→ SAR ALTIMETRY TRAINING COURSE

SAR Altimetry Tools

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21–22 October 2014 | Lake Constance | Germany

Presentation Outline

- SEOM
  - What is SEOM
- Sentinel-3
  - Quick view and data products
- BRAT
  - Current toolbox capabilities
- Sentinel-3 Altimetry Toolbox
  - Next generation toolbox
- Other tools
- SARvatore
  - ESA G-POD System Introduction
  - CryoSat-2 SAR Processing Service walkthrough and options

seom

scientific exploitation of operational missions

- **SEOM element objectives :**
  - Federate, support and expand the research community
  - Strengthen the leadership of European EO research community
  - Enable the science community to address new scientific research

seom
scientific exploitation of operational missions

ACTION LINES

esa

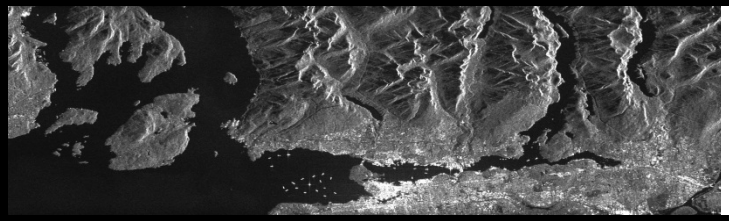
Research and Development Studies	Launching state-of-the-art R&D studies for scientific exploitation of operational missions
Scientific Toolboxes development	Developing, validating and maintaining open-source, multi-mission, scientific software toolboxes
Science Users Consultations	Organising a series of regular international thematic workshops for science users consultation and gathering science users feedback
Training Next Generation of Earth Observation Scientists	Offering a multi-year programme of advanced international training courses, summer schools and educational materials
Promoting Science Data use and Results	Promoting scientific use of data and ensuring a responsive ESA channel for regular, timely, high-quality scientific publications

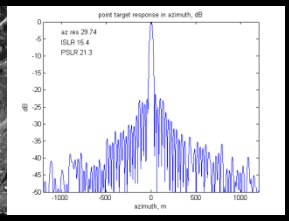
seom
scientific exploitation of operational missions

ACTION LINES

esa

Research and Development Studies





Scientific Toolboxes development

Science Users Consultations

Training Next Generation of Earth Observation Scientists

Promoting Science Data use and Results

Science User Consultations

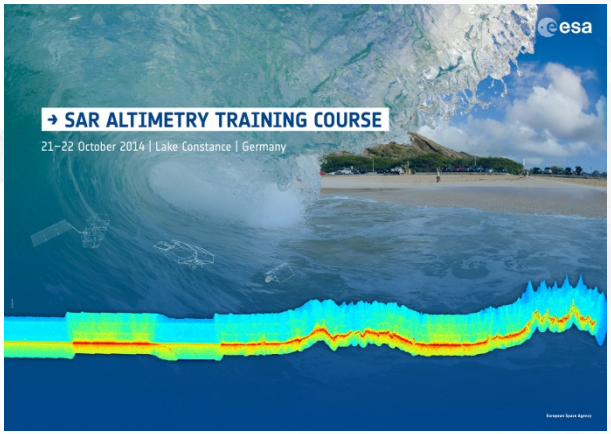
• **Living Planet Symposium 2013**: the 2013 Living Planet Symposium organised with UKSA, Edinburgh, United Kingdom 9 -13 September
www.esa.int/LivingPlanet2013 (with **1700 *participants*** *from* **60 *countries)***

• **COASTALWorkshop :** 8TH Coastal Altimetry workshop focused on the future Sentinel-3 Topography Mission 23-24 October 2014
http://www.coastalaltimetry.org

User Training

- **TRAINING COURSE on OCEAN REMOTE SENSING**, Cork Ireland , 23-27 Sept.2013
  - ~ 60 students

- **SAR Altimetry Training**
  - Lake Constance (DE)
  - 21 and 22 October 2014

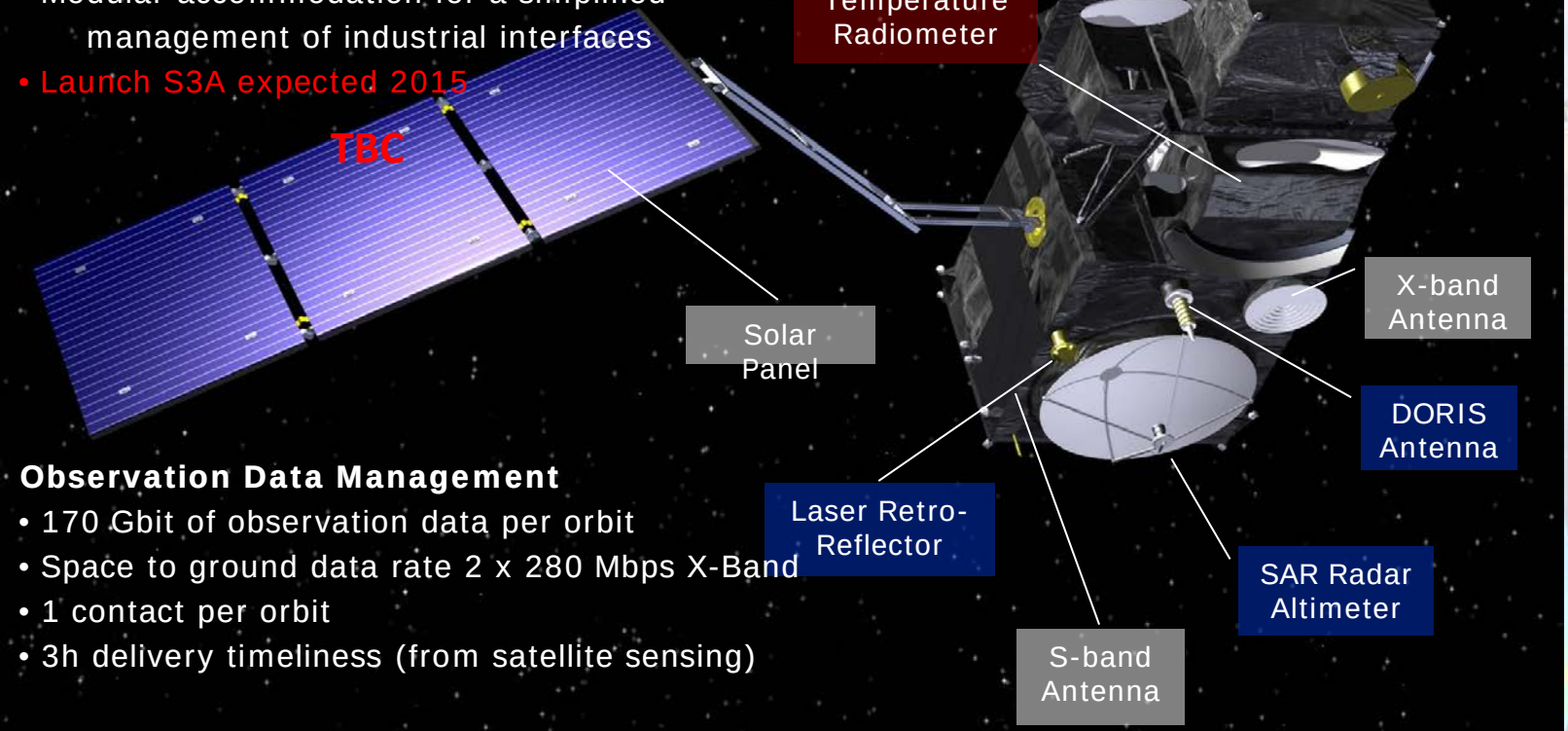


The Sentinel-3 Satellite

Main satellite characteristics

- 1250 kg maximal mass
- Volume in 3.89 m x 2.202 m x 2.207 m
- Average power consumption of 1100 W
- 7.5 years lifetime (fuel for 5 add. years)
- Large cold face for optical instruments thermal control
- Modular accommodation for a simplified management of industrial interfaces
- Launch S3A expected 2015

TBC

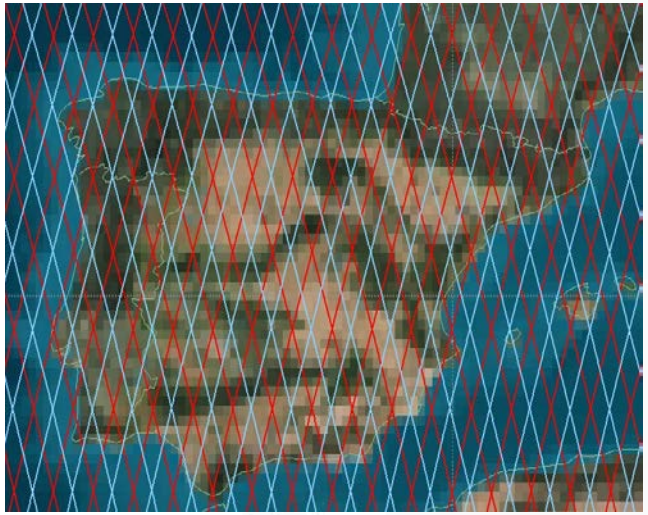


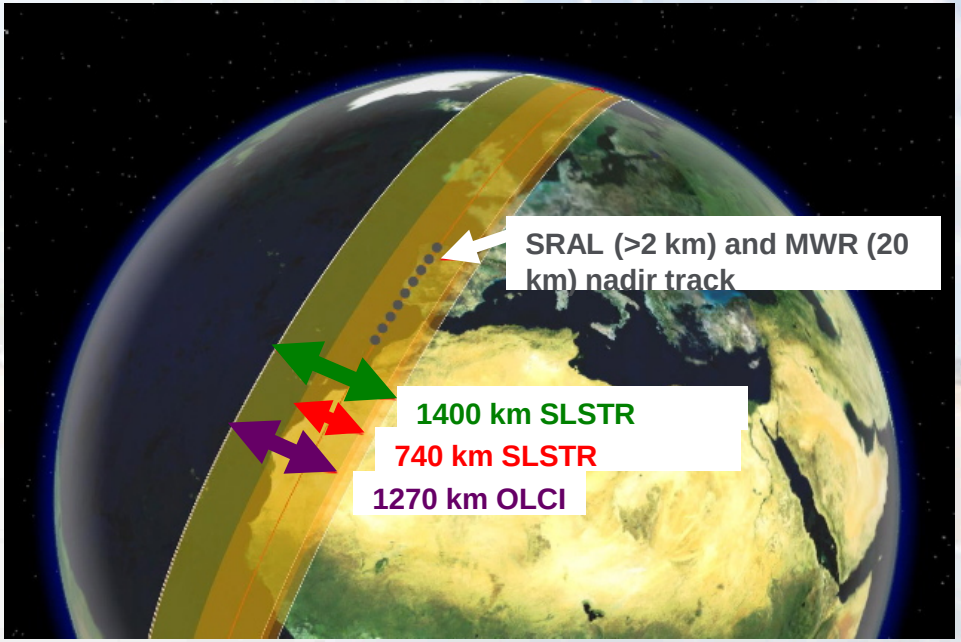
Observation Data Management

- 170 Gbit of observation data per orbit
- Space to ground data rate 2 x 280 Mbps X-Band
- 1 contact per orbit
- 3h delivery timeliness (from satellite sensing)

Sentinel-3 Orbit and Coverage

Topography Mission:
ground track repeatability, dense spatial sampling





Altimetry mission	Configuration	
Constellation	**1 Satellite**	**2 Satellites**
Main 27-day cycle inter-track separation at equator	**104 km**	**52 km**
4-day sub-cycle inter-track separation at the equator	**Min = 104 km** **Max = 728 km**	**Min = 57 km** **Max = 671 km**

Orbit type	Repeating frozen SSO
Repeat cycle	27 days (14 + 7/27 orbits/day)
LTDN	10:00 hr
Average altitude	815 km
Inclination	98.65 deg

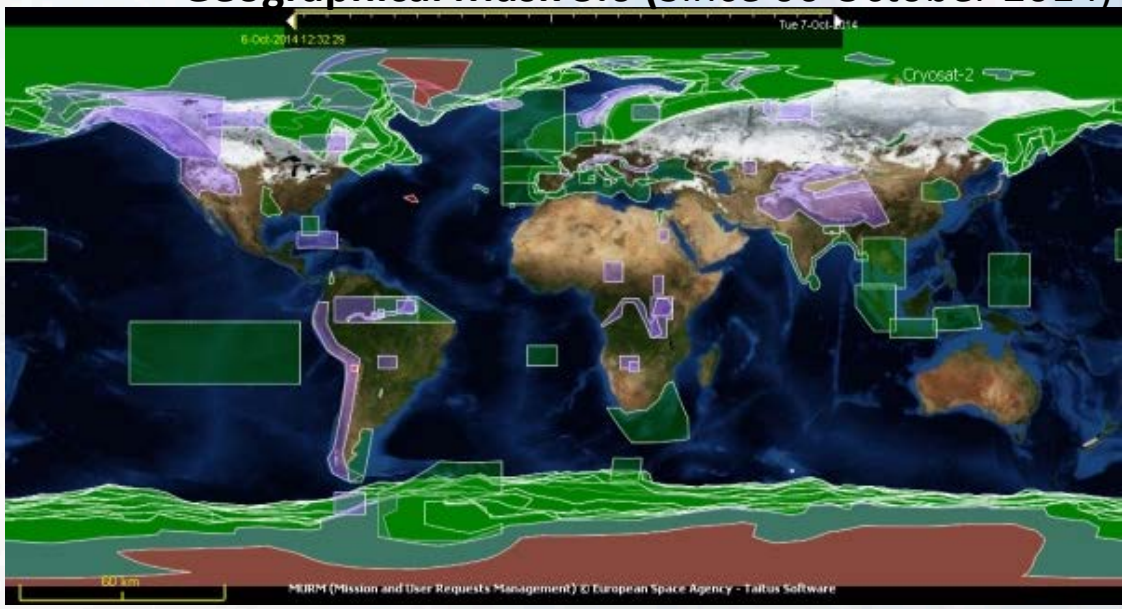
Cryosat-2 SAR mode

Currently SAR mode (green) is available in CryoSat-2.

SAR technology is still new and complex .

Further work required to understand all in-orbit conditions and emerging processing systems.

Geographical Mask 3.6 (Since 06 October 2014)



→ **See the output of Cryosat for Oceans (CP4O) Project**

- → **http://satoc.eu/projects/CP4O/index.html**
- → **Brochure available in the training/conference**

Sentinel-3 Acquisition mode

Original operational baseline: split between LRM and SAR mode

Autumn 2013: Request by the Copernicus user community to extend usage of SAR mode for the S-3 SRAL instrument up to 100% of Earth coverage -> ESA/EUMETSAT assessment approved by EC now for implementation, subject to a detailed cost/schedule assessment and final go ahead by EU

Note: it is assumed that the LRM shall be kept as a back-up to reduce operational risks and to allow a possible switch to the LRM scenario if necessary

Sentinel-3 and SAR mode

- Previously on L2 products were to be made available, but it was decided to release also L1 products.
- Expected advantages by ESA:
  - **Foster a new generation of SAR altimetry specialists** maintaining Europe at the competitive edge
  - **Enhance current and develop of new products over the Earth surface** (ocean, ice and land) within GMES
  - Enhance uptake, application, and quality control (e.g. transponder calibration) of SRAL SAR data products by the GMES user community
  - Possibly reduce large-scale reprocessing efforts (because starting from intermediate L1 products rather than from L0)

Sentinel-3 Future L1 User Products

- **L1 Products identified to become operational on Sentinel-3:**
  - ***L1A: Unpacked L0 complex echoes that have been sorted and calibrated.*** Geo-location information is also included. Product relevant to SAR processing specialists allowing fundamental studies on SAR processing such as Doppler beam formation and for calibration studies using ground-based Transponders.
  - ***L1B-S: Geo-located, calibrated azimuth formed complex (I and Q) echoes related to a given location on the ground, after slant range correction.*** No averaging of individual waveforms (i.e.multi-looking/stacking) is applied. Relevant ancillary data (e.g. beam angles, calibration information, statistical description of the multi-looked average/stack etc) is included. Product relevant to geophysical retrieval algorithm developers (over ocean, land and ice surfaces), surface characterisations studies (e.g. impact of sea state bias, wave directional effects etc) and Quality Control systems.
  - ***L1B: Geo-located, calibrated, azimuth formed, slant range corrected and averaged together (i.e multi-looked/stacked) power echoes associated with a fixed point on the ground-track.*** This product is relevant to geophysical retrieval algorithm developers and Quality Control systems.

→ **Products are to be read by Sentinel-3 Altimetry Toolbox**

Sentinel-3 L2 User Products

"Reduced" Measurement Data File

1 Hz LRM/SAR Ku/C Data Set
Sub-set of 1Hz Ku/C band parameters from SRAL measurements performed in LRM/SAR Modes

→ 1Hz

"Standard" Measurement Data File

1 Hz LRM/SAR Ku/C Data Set
1Hz Ku/C band parameters from SRAL measurements performed in LRM/SAR Modes

20 Hz LRM/SAR_C Data Set
20Hz C band parameters from SRAL measurements performed in LRM/SAR Modes

20 Hz LRM/SAR_Ku Data Set
20Hz Ku band parameters from SRAL measurements performed in LRM/SAR Modes

→ 1Hz + 20 Hz

"Enhanced" Measurement Data File

1 Hz LRM/SAR Ku/C Data Set
1Hz Ku/C band parameters from SRAL measurements performed in LRM/SAR Modes
PLRM Ku/C band measurement
20 Hz LRM/SAR_C Data Set
20Hz C band parameters from SRAL measurements performed in LRM/SAR Modes
PLRM Ku/C band measurement
20 Hz LRM/SAR_Ku Data Set
20Hz Ku band parameters from SRAL measurements performed in LRM/SAR Modes

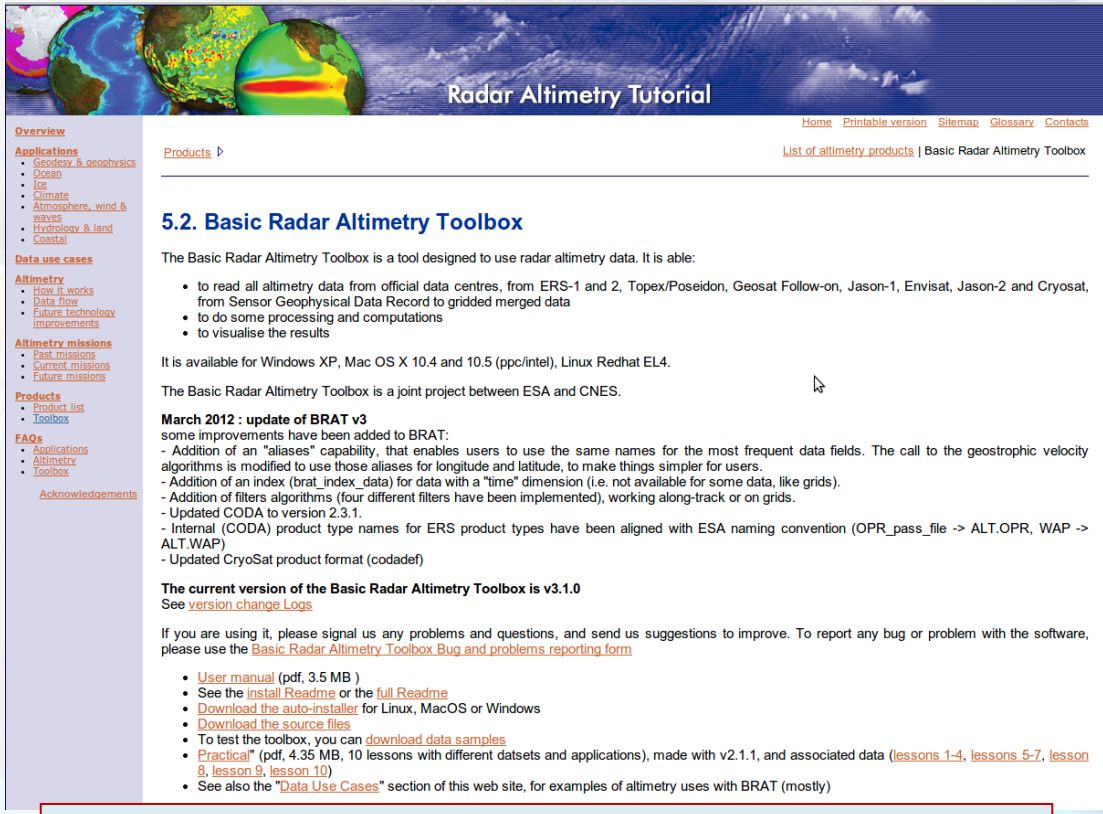
Waveforms
waveforms and associated parameters to reprocess the data (at least in LRM)
PLRM waveforms

→ 1Hz + 20 Hz + WF

→ **Products are to be read by Sentinel-3 Altimetry Toolbox**

BRAT - Introduction

- The **B**asic **R**adar **A**ltimetry **T**oolbox (BRAT) was launched in 2005 as a joint project funded by ESA (European Space Agency) and CNES (Centre National d'Etudes Spatiales).
- Last version 3.10 was launched in March 2012 and had around 1200 unique downloads (that about 12 new users per week!).


Radar Altimetry Tutorial
Home Printable version Sitemap Glossary Contacts
Overview
Applications
Geodesy & geophysics
Ocean
Ice
Climate
Atmosphere, wind & waves
Hydrology & land
Coastal
Data use cases
Altimetry
How it works
Data flow
Future technology improvements
Altimetry missions
Past missions
Current missions
Future missions
Products
Product list
Toolbox
FAQs
Applications
Altimetry
Toolbox
Acknowledgements
Products
List of altimetry products | Basic Radar Altimetry Toolbox
5.2. Basic Radar Altimetry Toolbox
The Basic Radar Altimetry Toolbox is a tool designed to use radar altimetry data. It is able:
to read all altimetry data from official data centres, from ERS-1 and 2, Topex/Poseidon, Geosat Follow-on, Jason-1, Envisat, Jason-2 and Cryosat, from Sensor Geophysical Data Record to gridded merged data
to do some processing and computations
to visualise the results
It is available for Windows XP, Mac OS X 10.4 and 10.5 (ppc/intel), Linux Redhat EL4.
The Basic Radar Altimetry Toolbox is a joint project between ESA and CNES.
March 2012 : update of BRAT v3
some improvements have been added to BRAT:
- Addition of an "aliases" capability, that enables users to use the same names for the most frequent data fields. The call to the geostrophic velocity algorithms is modified to use those aliases for longitude and latitude, to make things simpler for users.
- Addition of an index (brat_index_data) for data with a "time" dimension (i.e. not available for some data, like grids).
- Addition of filters algorithms (four different filters have been implemented), working along-track or on grids.
- Updated CODA to version 2.3.1.
- Internal (CODA) product type names for ERS product types have been aligned with ESA naming convention (OPR_pass_file -> ALT.OPR, WAP -> ALT.WAP)
- Updated CryoSat product format (codadef)
The current version of the Basic Radar Altimetry Toolbox is v3.1.0
See version change Logs
If you are using it, please signal us any problems and questions, and send us suggestions to improve. To report any bug or problem with the software, please use the Basic Radar Altimetry Toolbox Bug and problems reporting form
User manual (pdf, 3.5 MB)
See the install Readme or the full Readme
Download the auto-installer for Linux, MacOS or Windows
Download the source files
To test the toolbox, you can download data samples
Practical" (pdf, 4.35 MB, 10 lessons with different datsets and applications), made with v2.1.1, and associated data (lessons 1-4, lessons 5-7, lesson 8, lesson 9, lesson 10)
See also the "Data Use Cases" section of this web site, for examples of altimetry uses with BRAT (mostly)

Tool available for free download at

- earth.esa.int/brat
- altimetry.info

BRAT Main Functions:

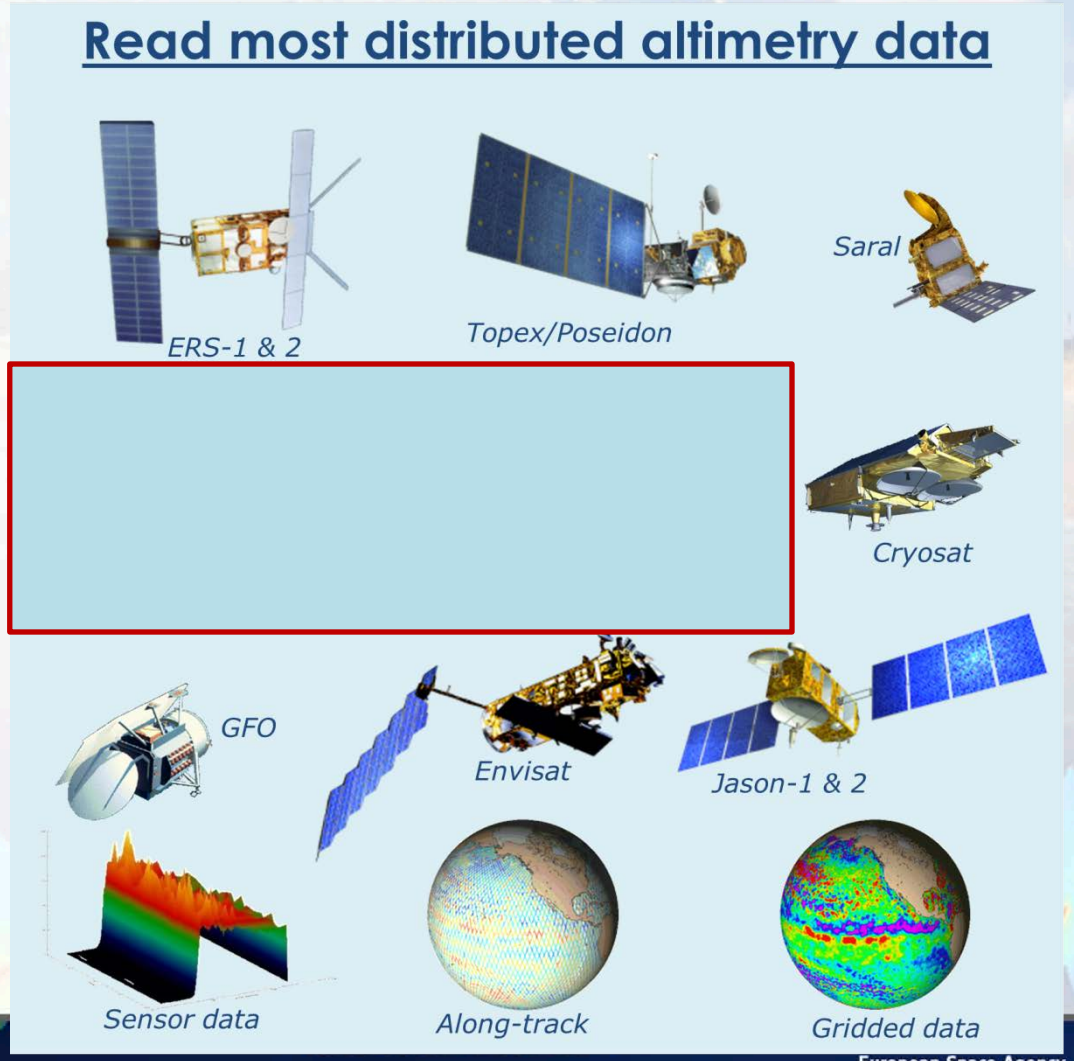
- **Data Import and Quick Look**: basic tools for extracting data from standard formats and generating quick-look images
- **Data Export**: output of data to NetCDF (ASCII dump provided). Raster images (png, jpeg, bmp, tiff, pnm) can be saved. KML + tiff output also possible.
- **Statistics:** calculation of statistical parameters (e.g. rms, average, variance)
- **Combinations:** computation of combinations of data fields
- **Resampling:** over and under sampling of data, data binning, filtering, smoothing
- **Data editing:** data selection using simple criteria or a combination of criteria
- **Exchanges:** data editing and combinations can be exchanged between users
- **Data visualisation:** Display of results, with user-defined preferences.

BRAT – Data Reading Capabilities

- BRAT is used to read and display all the past and present Radar Altimetry missions' products.

→ **Sentinel-3 Products are to be read by Sentinel-3 Altimetry Toolbox**

→ **Cannot be handled by BRAT**

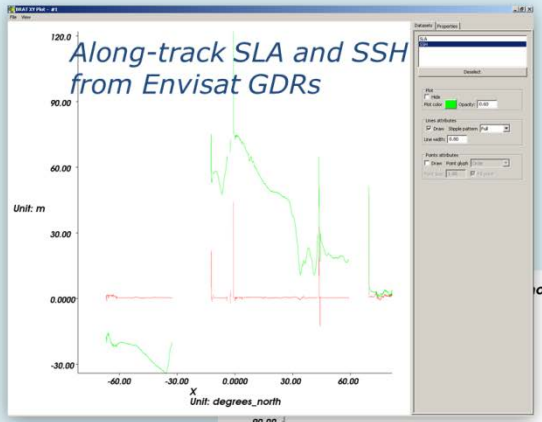


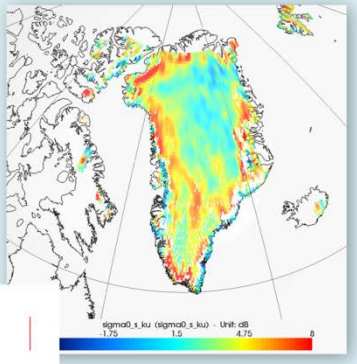
BRAT – Processing Capabilities

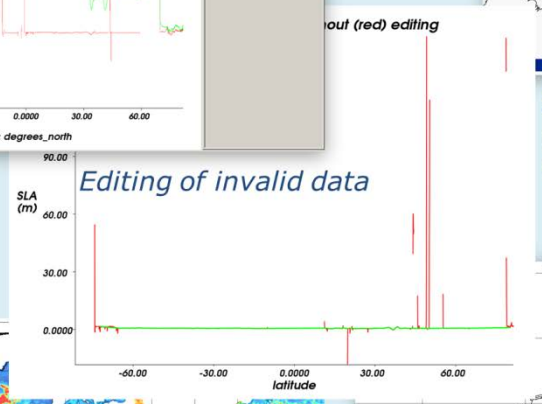
→ **New/Updated formulas for Sentinel-3 Altimetry Toolbox**

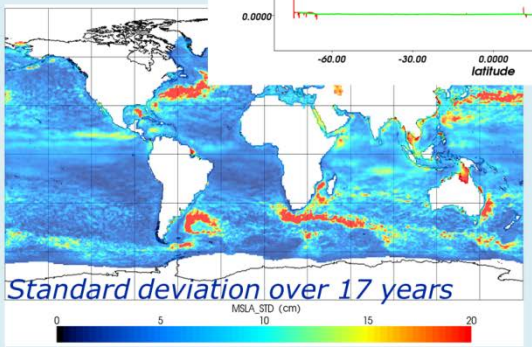
BRAT provides support for ingesting, processing (computation of formulas involving combinations of data fields; resampling of data; data selection using one/several criteria), generating statistics.

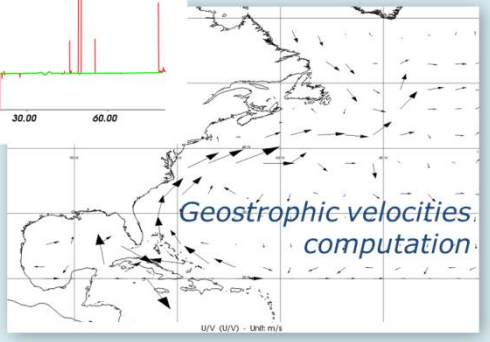
Process &select data











+ programming of processing / extraction routines (not using GUI)

Editing and Flagging Data

Data editing is necessary to remove altimeter measurements with low accuracy

➔ editing using flags

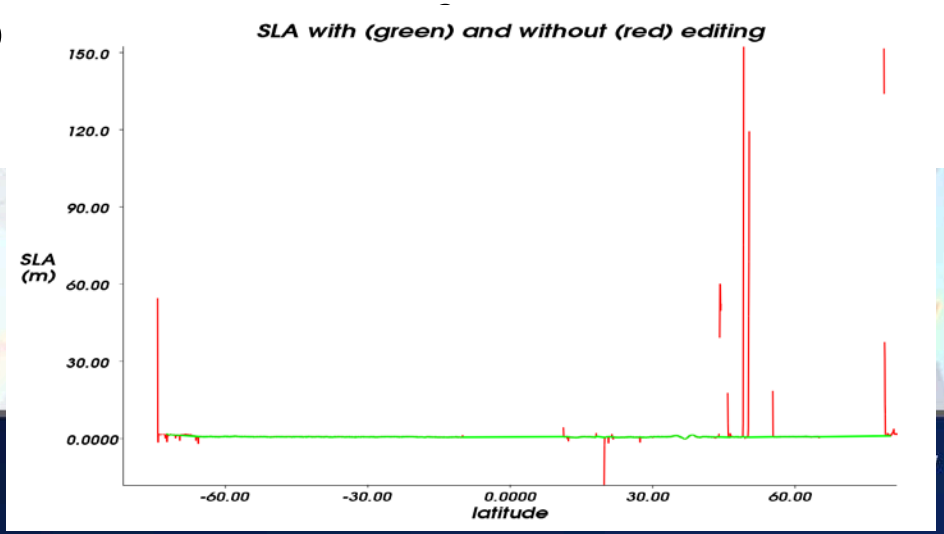
e.g. altim_landocean_flag = 0 (to maintain values over ocean only)

➔ editing using thresholds

E.g. -130 m < altitude –range < 100 m

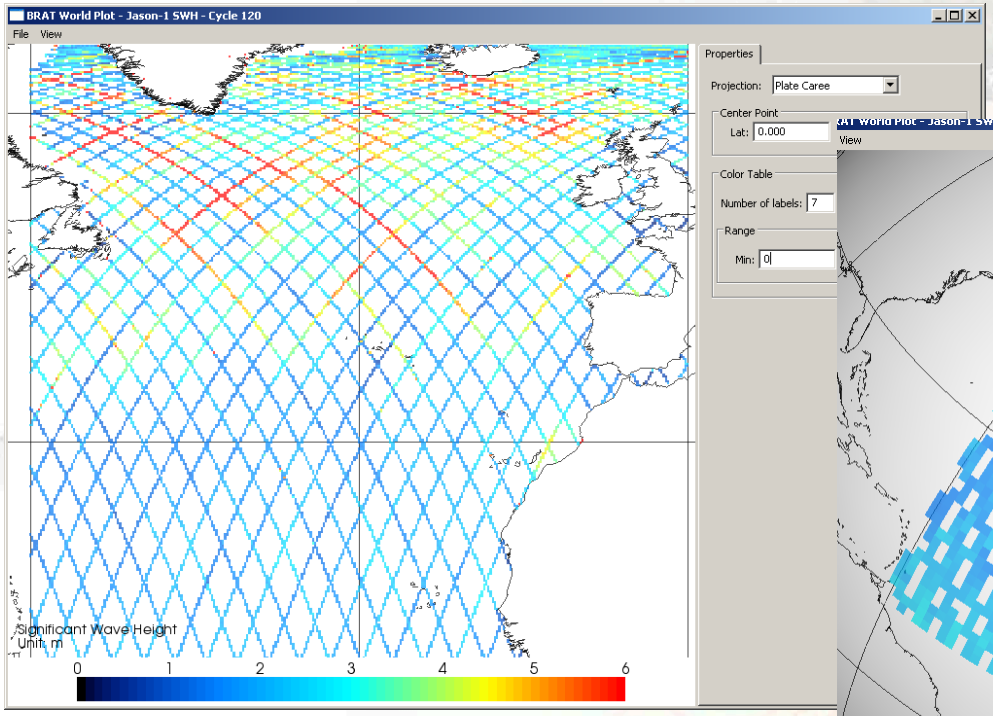
0 m < SWH < 11 m

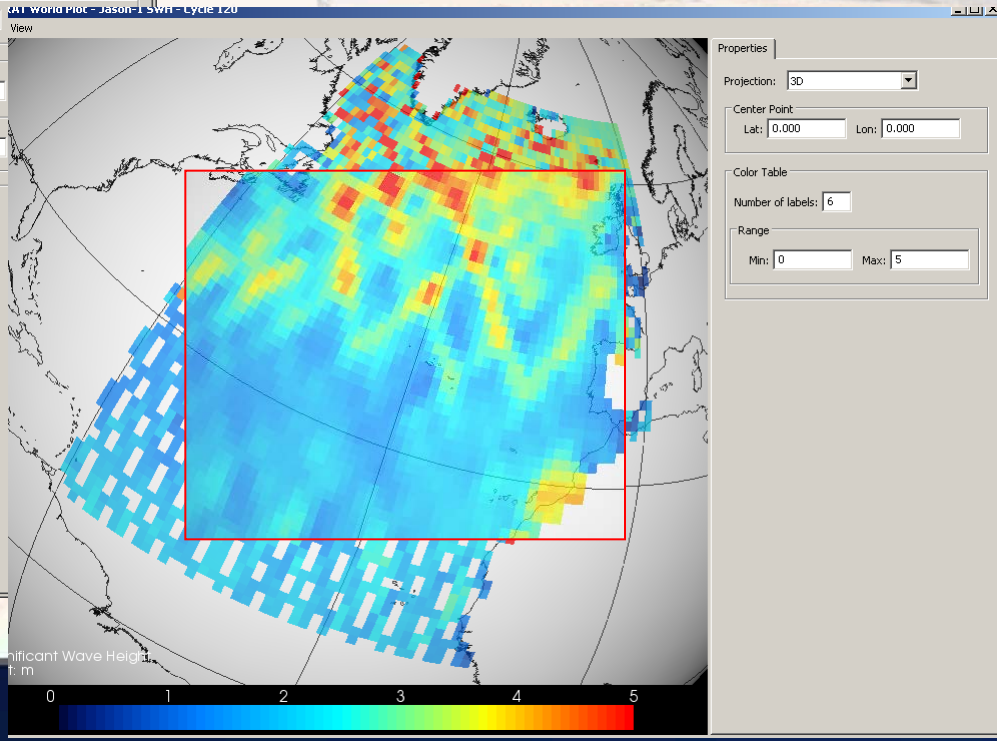
-0.2 deg² < antenna mispo



Resampling and Filtering Data

Data Binning enables users to fill up the gap between the satellite tracks by extrapolation, filtering and smoothing

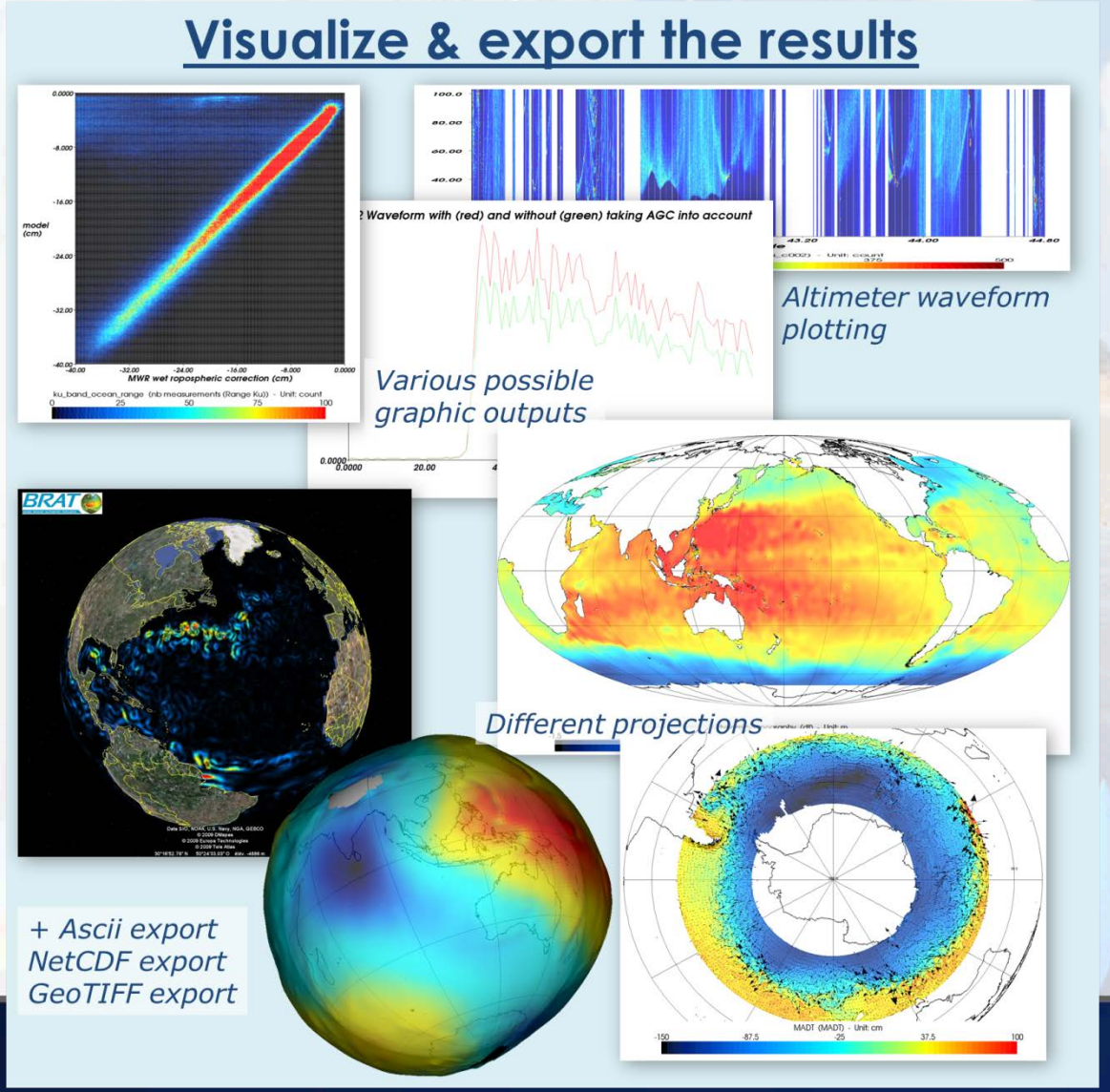




BRAT – Visualizing and Exporting

BRAT can also visualising and exporting the results in Image format (PNG, Geotiff, etc.) and in simple Google Earth's KML.

→ **The Sentinel-3 Altimetry Toolbox will improve the export capabilities allowing better KML support and automatic (scripting) image generation.**



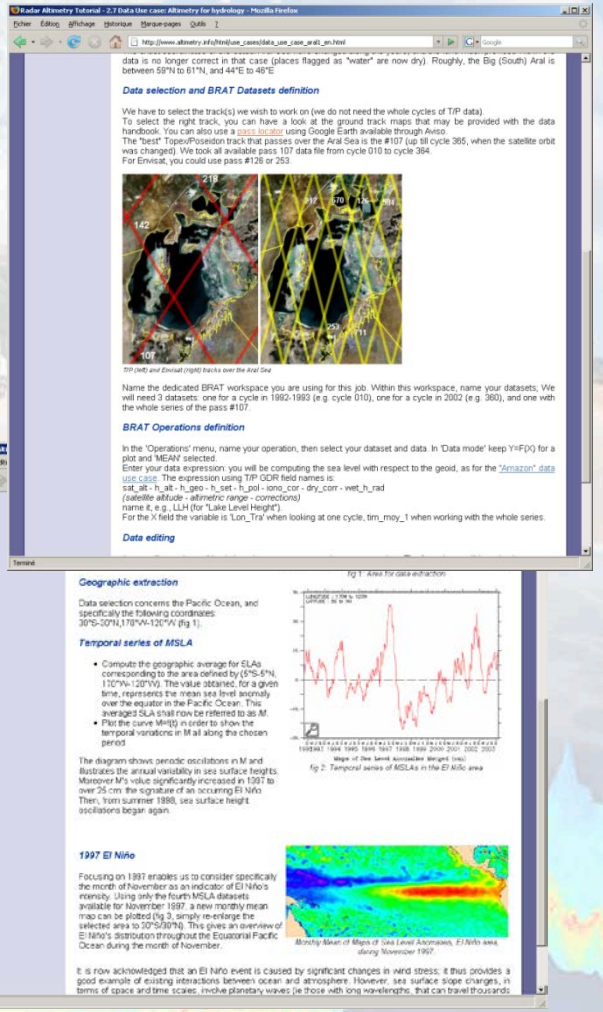
BRAT - Under the hood

BRAT consists of several modules operating at different levels of abstraction. These modules can be Graphical User Interface applications (GUIs), command-line tools, interfaces to existing applications (such as IDL and MATLAB) or application program interfaces (APIs) to programming languages such as C and Fortran.

→ **The Sentinel-3 Altimetry Toolbox will follow the same structure.**

Radar Altimetry Tutorial

The **Radar Altimetry Tutorial** (RAT) is also part of the BRAT suite and gives general information about altimetry, the techniques involved and their applications, as well as an overview of the missions. It also presents a series of **data use cases**, covering all uses of altimetry over ocean, cryosphere and land, showing the basic methods for some of the most frequent manners of using altimetry data.

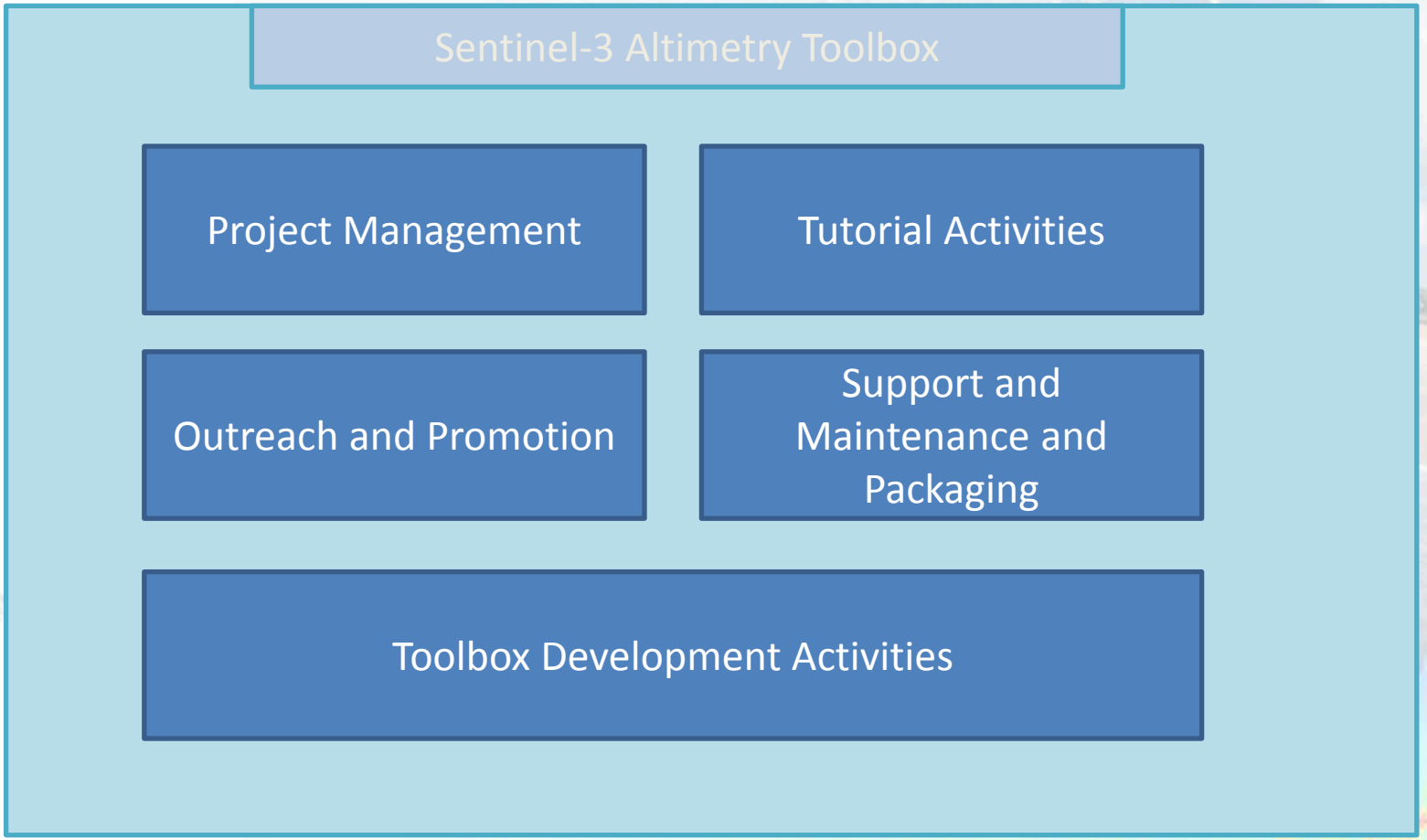


→ **The Sentinel-3 Altimetry Toolbox will have more tutorial material**

Sentinel-3 Altimetry Toolbox

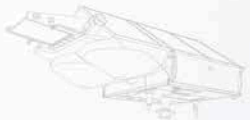
- In order to correct some of the shortcomings of BRAT and update the Altimetry Tolbox to handle Sentinel-3 data ESA has issued an ITT (Invitation to Tender) for the Sentinel-3 Altimetry Toolbox (now closed).
- Expected KO late 2014/early 2015.

Project Organization



Toolbox development activities

- Data Improvements
- Computation
- User Interface
- Data Export
- Underneath the Hood
- Technical Documents & User Manual



Toolbox development activities

- Data Improvements
  - Netcdf 4 read/write
  - Sentinel-3 Data
    - L1A, L1BS, L1B, L2 (in the different flavours)
  - Cryosat-2 Ocean Products and Baseline C
  - ERS Reaper Products
  - Geosat GDR data
  - Update of River and Lake Products Handling

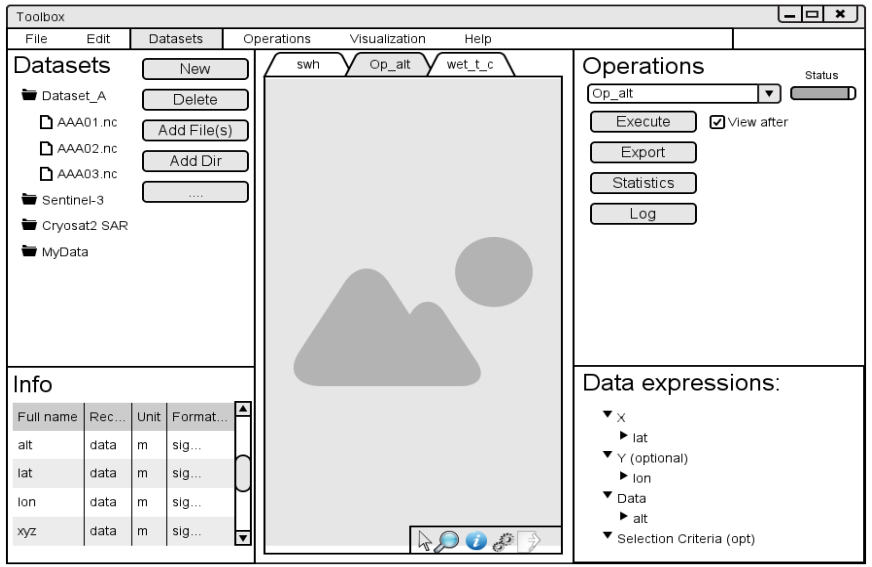
Toolbox development activities

- Data Improvements
- Computation
  - Update Built-in Formulas
  - Coastal and Inland Waters Altimetry Formulas
  - User-Defined Algorithm Module & Python API
  - Interpolation Algorithm Module
- User Interface
- Data Export
- Underneath the Hood
- Technical Documents & User Manual

Toolbox development activities

User Interface

- Update Visualization Component
  - Enhanced Display Background
    - High Resolution for Coastal zone for instance
  - Plot Track Data
  - Regression Line Plotting
  - Several updates/corrections



New user interface (Mockup)

Toolbox development activities

- Data Improvements
- Computation
- User Interface
- Data Export
  - ASCII Export Viewer
  - Addition of Image Export
  - Improvements in KMZ/KML Export
- Underneath the Hood
- Technical Documents & User Manual

Toolbox development activities

- Underneath the Hood
  - Support 64 bits system
  - External Code Contributions
    - Reading of Hydroweb Products
    - Reading 3D Data
    - HY-2A Products
    - Computation of Alternative SSB
    - Statistics Computation
    - Unit Aware Inequality Operators

Windows / Linux / Mac OS X

Open-Source Software.
To be done via source code repository.

Releases and Duration

- Project Duration: 36 months
  - 24 months of active development
  - 12 months of maintenance and user support

- Major software releases planed
  - Version A: 6 months after KO
    - ~ April/May 2015
  - Version B: 12 months after KO
    - ~ December 2015
  - Version C: 18 months after KO
    - ~ April/May 2016
  - Bug-fix releases are also planed for the maintenance period.

Other Tools

- Cryosat Matalab routines
  - Allows reading of L1b and L2 files from Cryosat.
  - https://earth.esa.int/web/guest/software-tools/-/article/cryosat-matlab-routines
- CryoSat User Tool (CUT)
  - The CryoSat User Tool (CUT) is a Windows stand-alone application for displaying and downloading CryoSat products from remote FTP servers
  - https://earth.esa.int/web/guest/software-tools/content/-/article/cryosat-user-tool-cut-7805
- CryoView
  - CryoView is a tool capable of opening and decoding CryoSat data. It then displays the contents as tables, graphs or as images as appropriate.
  - https://earth.esa.int/web/guest/software-tools/content/-/article/cryoview-6972

Other Tools

- **Cryosat Ground Tracks**
  - Cryosat orbit files are provided to Cryosat users to support data analysis, and planning and airborne campaign execution
  - The Reference Orbit, The Reference Ground Track, FOS Predicted Orbit
  - https://earth.esa.int/web/guest/-/ground-tracks-7209

SAR Versatile **A**ltimetric **T**oolkit for **O**cean **R**esearch & **E**xploitation

SAR mode

Versatile

Altimetric **T**oolkit

For **O**cean

Research & **E**xploitation

SARvatore

G-POD Distributed Environment

The **ESA Grid Processing on Demand** system is a generic GRID-based operational computating environment where specific data-handling Earth-Observation services can be seamlessly plugged into system. One of the goal of G-POD is to provide users with a fast computational facility without the need to handle bulky data.

The G-POD system hosts high-speed connectivity, distributed processing resources and large volumes of data to provide scientific and industrial partners with a shared data processing platform fostering the development, validation and operations of new Earth Observation applications.

In particular, the G-POD environment consists of:

- Over **350** CPU in about 70 Working Nodes
- Over **330** TB of local on-line Storage plus 180 TB of EO data accessed directly from the PACs.
- Access to Cloud processing and data resources on demand (from Interoute and other providers)
- Internal dedicated 1 Gbit LAN at ESRIN and at UK-PAC archives
- 1 Gbps external connection
- Software Resources on-line: IDL, Matlab, BEAT, BEAM, BEST, CQFD, NEST, BRAT, Gamma
- System: GRID Globus on Linux

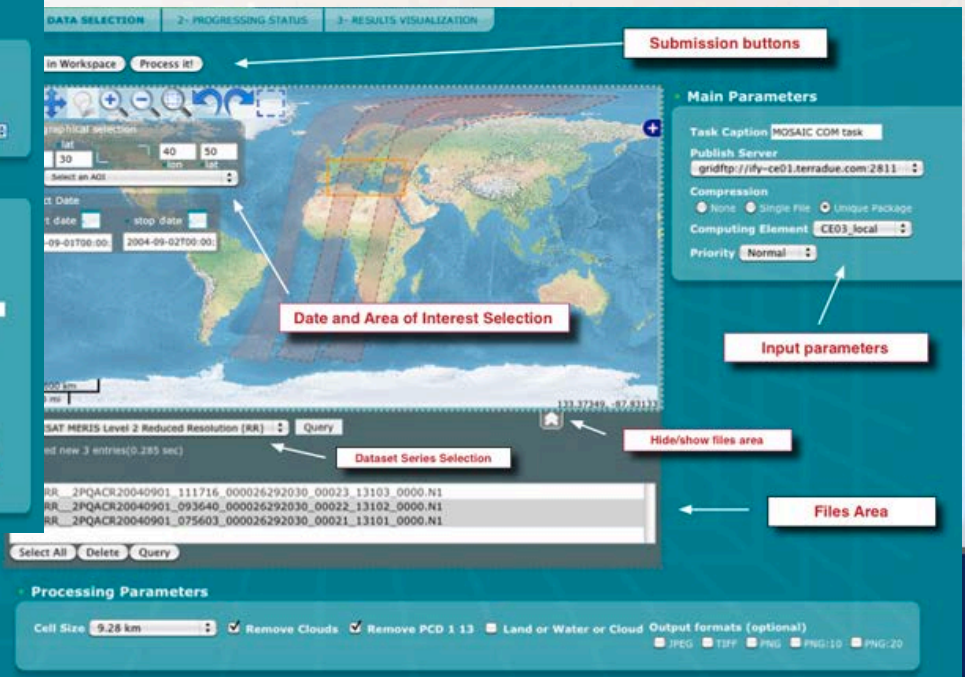
Actually, G-POD has more than **300TB** of EO data locally stored.
EO Data available to G-POD services come either from ESA and from not-ESA mission.

g-pod
grid processing on demand

G-POD Web Portal

The **G-POD web portal** is a flexible, secure, generic and distributed web platform where the user can easily manage all own tasks. From the creation of a new task to the output publication, passing by the data selection and the job monitoring, the user goes trough a **friendly** and **intuitive** user interface accessible from everywhere.

More info on the G-POD Web Portal are available here: http://wiki.services.eoportal.org/tiki-index.php?page=GPOD+User+Manual#Annex



G-POD Services Portfolio

The EO services currently integrated in G-POD are:

AARDVARC
aeromeris
algal1
AMORGOS
Antarctica
ASARP
BEAMARITHM
BeamReproject
BIOMASAR-II
BRAT
download
ESCATSM
FAIRE2
GEOFIT

GlobTemperature
GMESCQC
GUT
Imager
INSAR
JLOEP
JURASSIC
KLIMA
LandsatIPF
MCFS
MGVIJRC2
MGVIRegional
MIOPS
MKL3
MOSAICOM

MSGBaroncini
MSGTimeseries
NEST
PHAVEOS
RAIES
RIVERLAKE2
SAROTECnFLO
SARVATORE
SMOSL1
SMOSL2OS
SMOSL2SM
SOIL MAPPER
SSEGridFAPAR
VASD
vomit
WACMOS

RAIES

- First altimetry project to use the GPOD (ancestor) power
- **RAIES**: Exploitation of the ENVISAT Radar Altimeter Individual Echoes and S-band data for ocean, coastal zone, land and ice/sea-ice altimetry
  - Aimed at providing users with full processed RA-2 Ku band individual echoes (1800 Hz) for further research.
  - The individual waveform samples (after IF mask processing), the IE phases, window delay and sigma0 calibration factors are available in the output products.

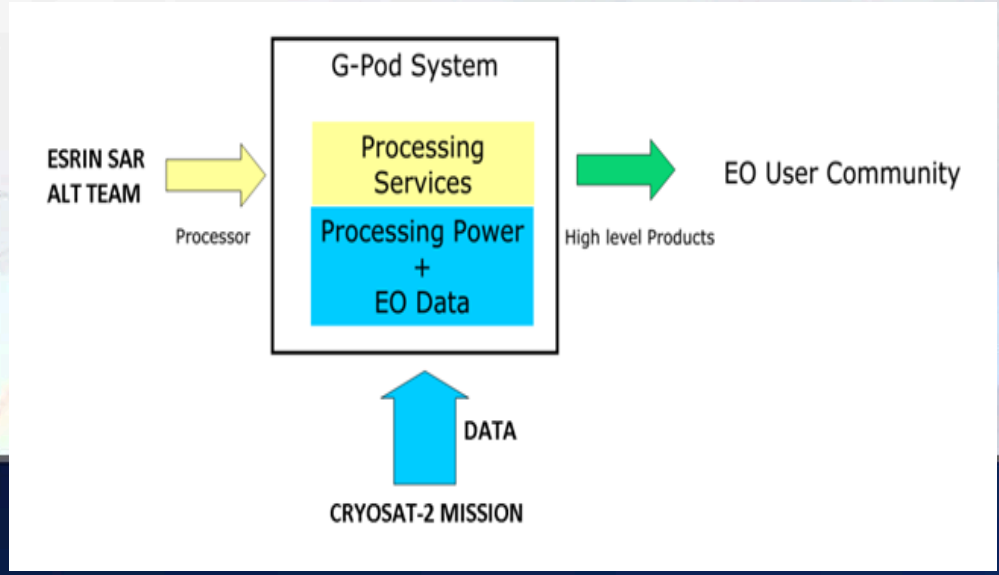
GPOD CryoSat SAR Processing Service

The ESA G-POD Service, SARvatore (**SAR** **V**ersatile **A**ltimetric **T**oolkit for **O**cean **R**esearch & **E**xploitation) for CryoSat-2 is an Earth-Observation application that provides the capability to process remotely and on demand CryoSat-2 SAR data, from L1a (FBR) data products until SAR Level-2 geophysical data products.

The service works over any kind of surfaces but it has been so far optimized for ocean studies.

It will be "soon" enhanced for inland waters and land domains.

SARvatore for CryoSat-2
Name SARvatore for CryoSat-2
Classification D
Rating
Service Description SARvatore (SAR Versatile Altimetric Toolkit for Ocean Research and Exploitation) for CryoSat-2 is a Software Processor Prototype developed in ESA/ESRIN to experiment with SAR processing from L1a (FBR) to L2 using the SAMOSA model. It can be used over open ocean or coastal zone, as well as more difficult targets such as rivers and lakes. This toolkit is made available to the user community as EO G-POD Service and features an handy graphic user interface. The toolkit takes in input Cryosat-2 SAR FBR data products and produces in output geophysical L2 products in standard netcdf format. This output can be manipulated and visualized with BRAT (ESA Basic Altimetry Radar ToolBox).

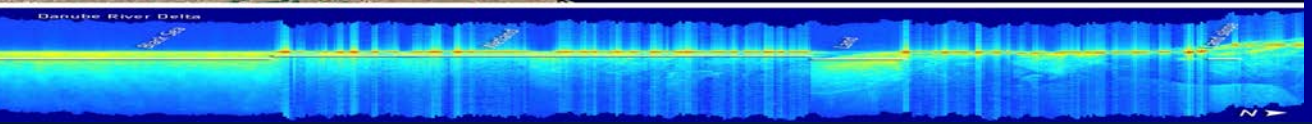


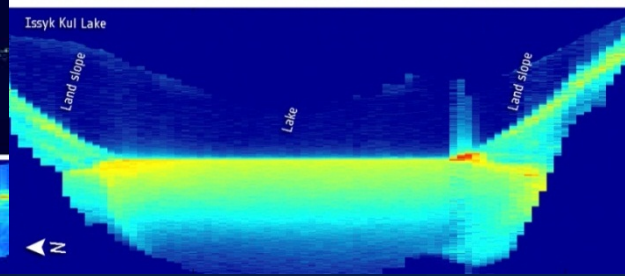
g-pod
grid processing on demand

CryoSat-2 Processor Prototype

The service is based on the SAR Processor Prototype that has been developed entirely by EOP-SER Altimetry Team (Salvatore Dinardo, Bruno Lucas, Jerome Benveniste) for CryoSat-2 validation purposes and preparation to Sentinel-3 mission, with the following system features:

- SAR/SARin L1b Processor Prototype (Standard Delay-Doppler Processing)
- SAR/SARin L2 Retracker Prototype (with SAMOSA Analytical Model and LEVMAR Least Square Estimator)
- Input: CRYOSAT SAR/SARIN FBR DATA
- Output L1b → Radar Echogram
- Output L2 → SSH, SLA (W/O SSB), SWH, sigma0, wind speed



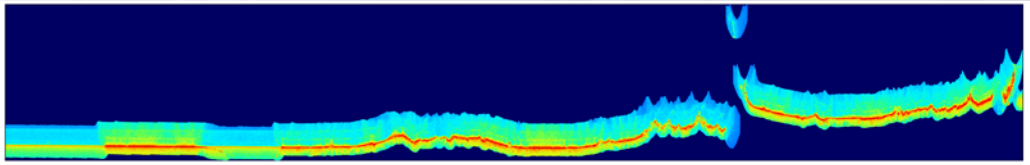


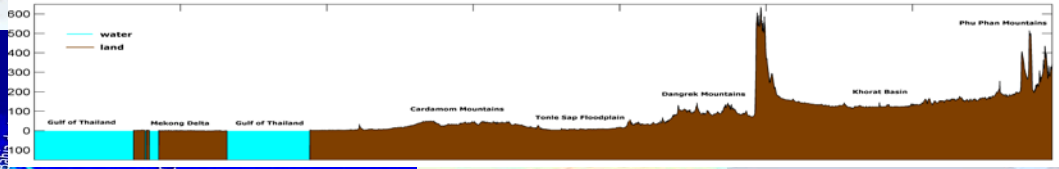
CryoSat-2 Processor Prototype

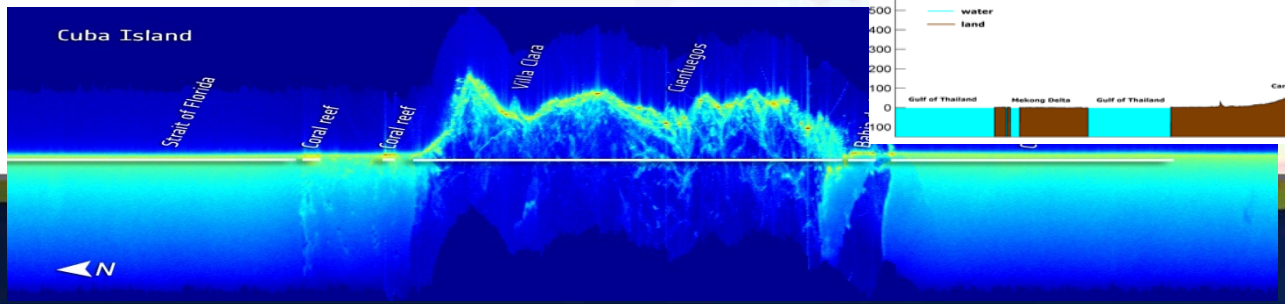
ESRIN EOP-SER ALT team compiled the processor's Matlab source code into a 64-bit Linux binary and delivered to ESA G-POD team the executable codes, the input archive (SAR FBR) and satellite footprints (ASCII tracks).
Now, the toolkit has been fully integrated in the GPOD System for gridded and on demand computation.

The objectives of the service integration in GPOD are:

- to experiment in-house research themes that will be further exploited in the ESA-funded R&D projects
    - to validate CryoSat-2 for ocean applications and get prepared to exploitation of Sentinel-3 mission
- to provide expert users with consolidated SAR geo-products to get acquainted with the novelties and specifities of SAR A





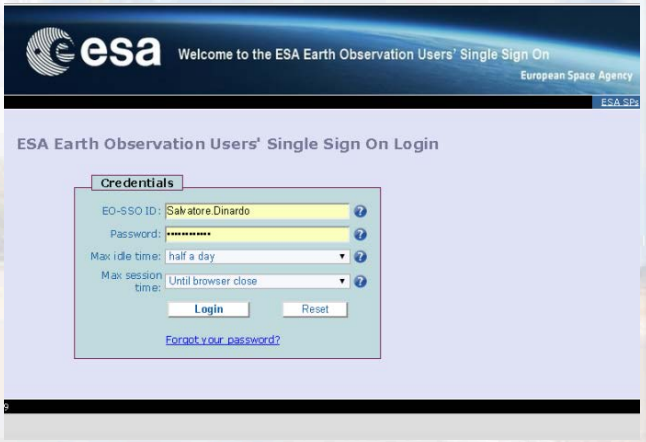


Service Registration and Access

- The service is **open, free of charge and accessible on line from everywhere**.
- In order to be granted the access to the service, you need to have an EO-SSO (Earth Observation Single Sign-On) credentials (for EO-SSO registration, go at https://earth.esa.int/web/guest/general-registration) and afterwards, you need to submit an e-mail to G-POD team (write to eo-gpod@esa.int), requesting the activation of the SARvatore service for your EO-SSO user account
- After a registration to EO SSO, user can freely access at the on line service at:

  https://gpod.eo.esa.int/services/CRYOSAT_SAR/

- The service is listed under the Marine Theme or you can find through the search bar as well.

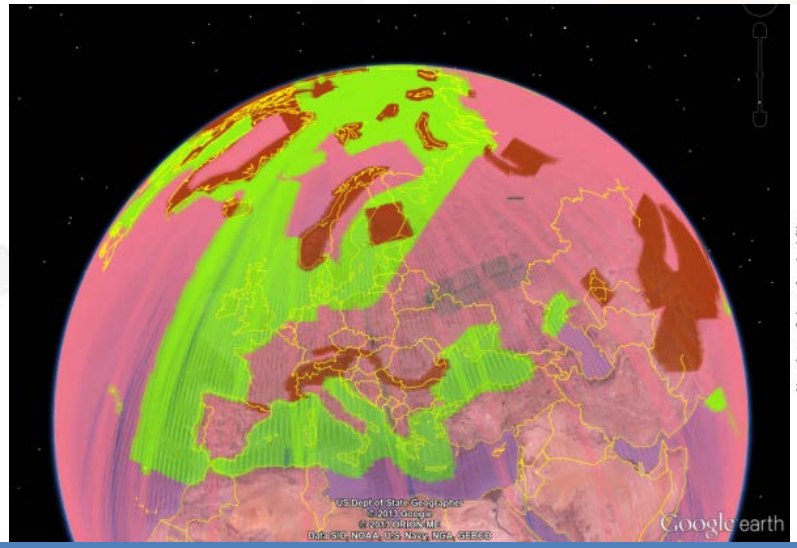


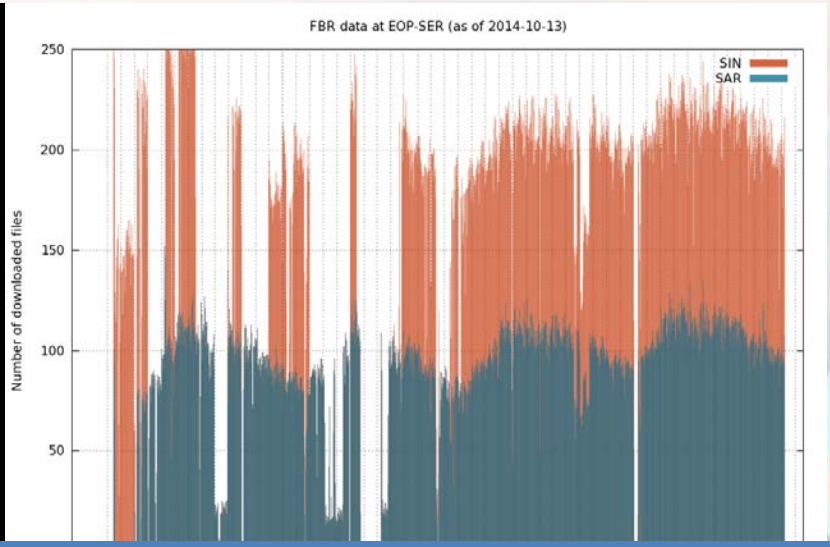
CryoSat-2 DATA Catalogue in G-POD

The current GPOD service works only in **SAR Mode** (no SARIN or LRM mode).

So far, in the service catalogue, we have stored ~**100 thousands** of SAR passes over the all globe for the years 2010, 2011, 2013 and part of 2014 and 2012.
This amount to **16 TB** of CryoSat-2 FBR data archived into G-POD storage.

Data obtained from EOP-SER (historical) and CS2 ftp servers (current).





Partial historical archive (<2012/05) were gratefully provided by NOAA/RADS and ESTEC

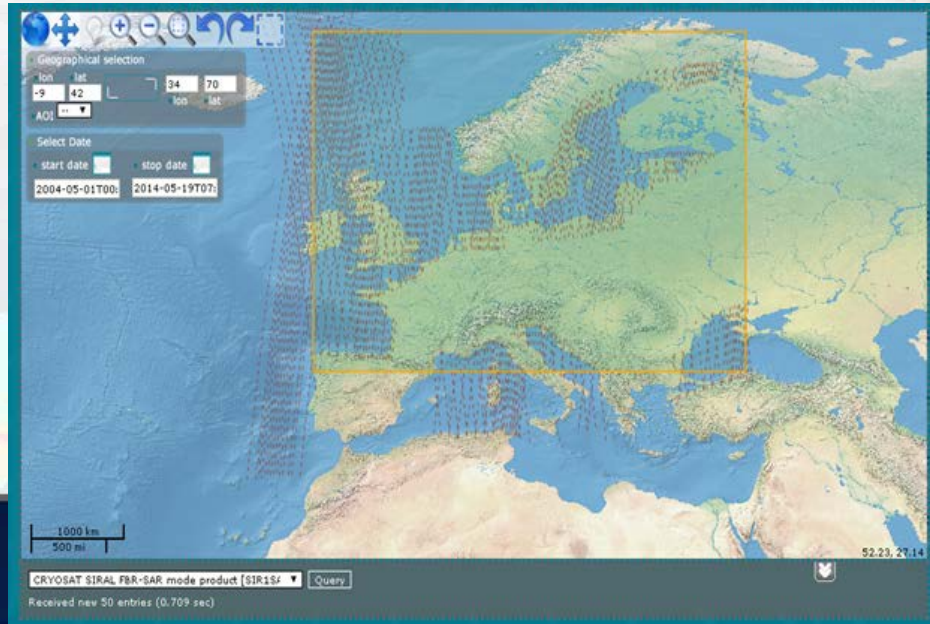
The Service Graphical User Interface

Once get to the service page, the first action to operate is to select **the zone of interest** and **the time of interest** for the required run.

Regarding the selection of the area of interest, the user can simply **draw a rectangle** in the world map, after clicking on the rectangle icon on the tool bar. Instead, for more precise geo-selection, the user can type directly the geo-coordinates of the area of interest using the geographical boxes.

Regarding the time of interest, the user may set the start date and the stop date in the calendar bar. By default, the start date is the time of CryoSat-2 launch time and the stop date is set at 2 months prior to the current date.

The GUI embeds all the standard buttons for image browsing as panning, zoom-in zoom-out, centering, undo, redo, reset, etc.

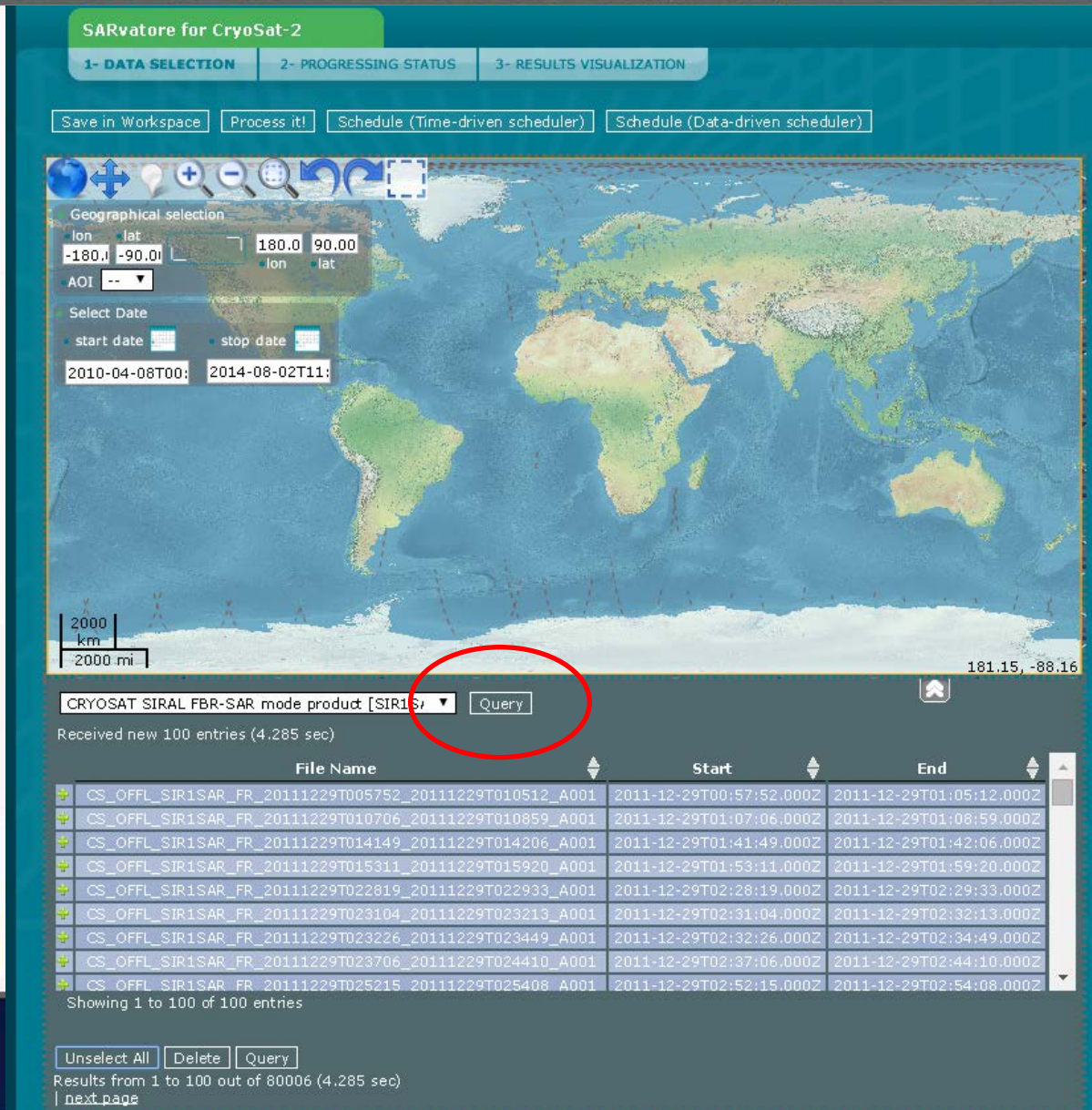


DATA SELECTION

Once operated the time and geo selection, clicking on the "**QUERY**" button, the service lists all the CryoSat-2 passes matching the time and space requirements. The CryoSat-2 SAR tracks, crossing the area of interest, are then shown on the world map in overlay.

The graphical interface lists at maximum 100 passes for page and informs users of the total number of found passes.

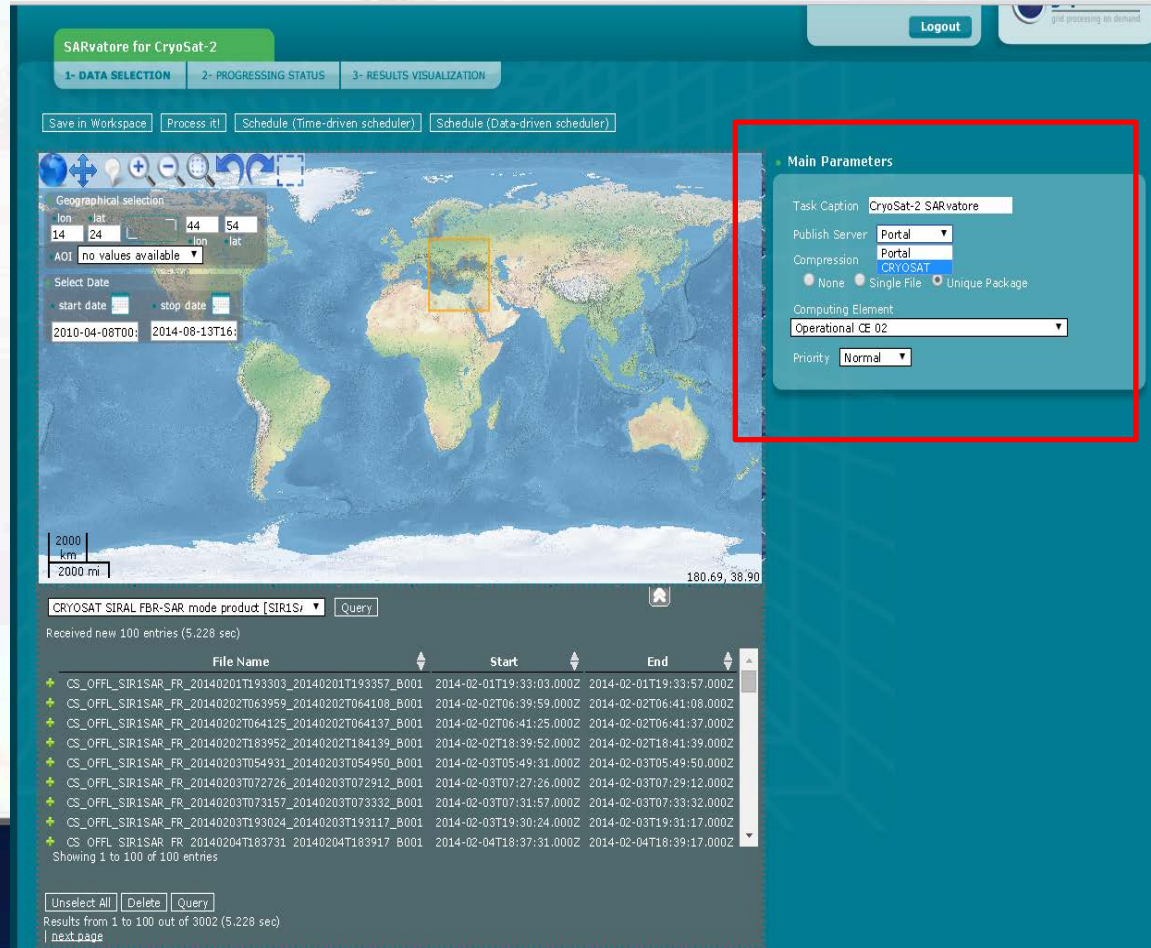
The user can decide which passes to select clicking on the passes, select all, or delete some specific passes from the list.



SESSION PREFERENCE PANEL

On the top right, user finds a preference panel wherein user can set:

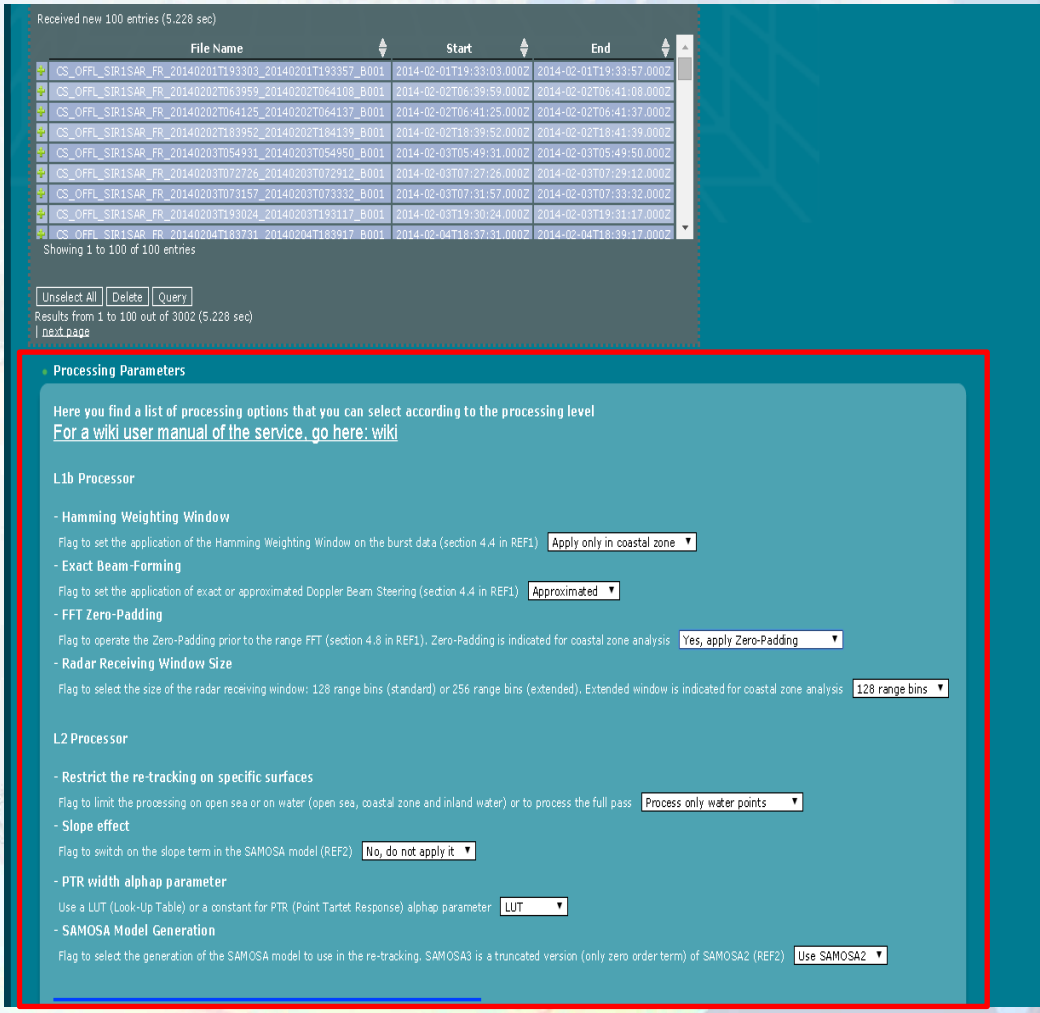
- Name of the current task
- Ftp Server where to publish the results (portal or personal)
- Data compression (tgz, none)
- Grid Computing Resources
- Task Priority



LIST OF PROCESSING OPTIONS

The last step, before to submit the task, is to set the list of processing options.

- Indeed, the processor prototype is **versatile** in the sense that the users can customize and adapt the processing, according their specific requirements, setting a list of configurable options.
- In the G-POD interface, user can enter easily this list of processing options via a series of drop-down menu. The configurable options are divided according to the processing level they refer to (L1b and L2).


Received new 100 entries (5.228 sec)
File Name
Start
End
CS_OFFL_SIR1SAR_FR_20140201T193303_20140201T193357_B001
2014-02-01T19:33:03.000Z
2014-02-01T19:33:57.000Z
CS_OFFL_SIR1SAR_FR_20140202T063959_20140202T064108_B001
2014-02-02T06:39:59.000Z
2014-02-02T06:41:08.000Z
CS_OFFL_SIR1SAR_FR_20140202T064125_20140202T064137_B001
2014-02-02T06:41:25.000Z
2014-02-02T06:41:37.000Z
CS_OFFL_SIR1SAR_FR_20140202T183952_20140202T184139_B001
2014-02-02T18:39:52.000Z
2014-02-02T18:41:39.000Z
CS_OFFL_SIR1SAR_FR_20140203T054931_20140203T054950_B001
2014-02-03T05:49:31.000Z
2014-02-03T05:49:50.000Z
CS_OFFL_SIR1SAR_FR_20140203T072726_20140203T072912_B001
2014-02-03T07:27:26.000Z
2014-02-03T07:29:12.000Z
CS_OFFL_SIR1SAR_FR_20140203T073157_20140203T073332_B001
2014-02-03T07:31:57.000Z
2014-02-03T07:33:32.000Z
CS_OFFL_SIR1SAR_FR_20140203T193024_20140203T193117_B001
2014-02-03T19:30:24.000Z
2014-02-03T19:31:17.000Z
CS_OFFL_SIR1SAR_FR_20140204T183731_20140204T183917_B001
2014-02-04T18:37:31.000Z
2014-02-04T18:39:17.000Z
Showing 1 to 100 of 100 entries
Unselect All
Delete
Query
Results from 1 to 100 out of 3002 (5.228 sec)
next page
Processing Parameters
Here you find a list of processing options that you can select according to the processing level
For a wiki user manual of the service, go here: wiki
L1b Processor
- Hamming Weighting Window
Flag to set the application of the Hamming Weighting Window on the burst data (section 4.4 in REF1)
Apply only in coastal zone
- Exact Beam-Forming
Flag to set the application of exact or approximated Doppler Beam Steering (section 4.4 in REF1)
Approximated
- FFT Zero-Padding
Flag to operate the Zero-Padding prior to the range FFT (section 4.8 in REF1). Zero-Padding is indicated for coastal zone analysis
Yes, apply Zero-Padding
- Radar Receiving Window Size
Flag to select the size of the radar receiving window: 128 range bins (standard) or 256 range bins (extended). Extended window is indicated for coastal zone analysis
128 range bins
L2 Processor
- Restrict the re-tracking on specific surfaces
Flag to limit the processing on open sea or on water (open sea, coastal zone and inland water) or to process the full pass
Process only water points
- Slope effect
Flag to switch on the slope term in the SAMOSA model (REF2)
No, do not apply it
- PTR width alphap parameter
Use a LUT (Look-Up Table) or a constant for PTR (Point Tartet Response) alphap parameter
LUT
- SAMOSA Model Generation
Flag to select the generation of the SAMOSA model to use in the re-tracking. SAMOSA3 is a truncated version (only zero order term) of SAMOSA2 (REF2)
Use SAMOSA2

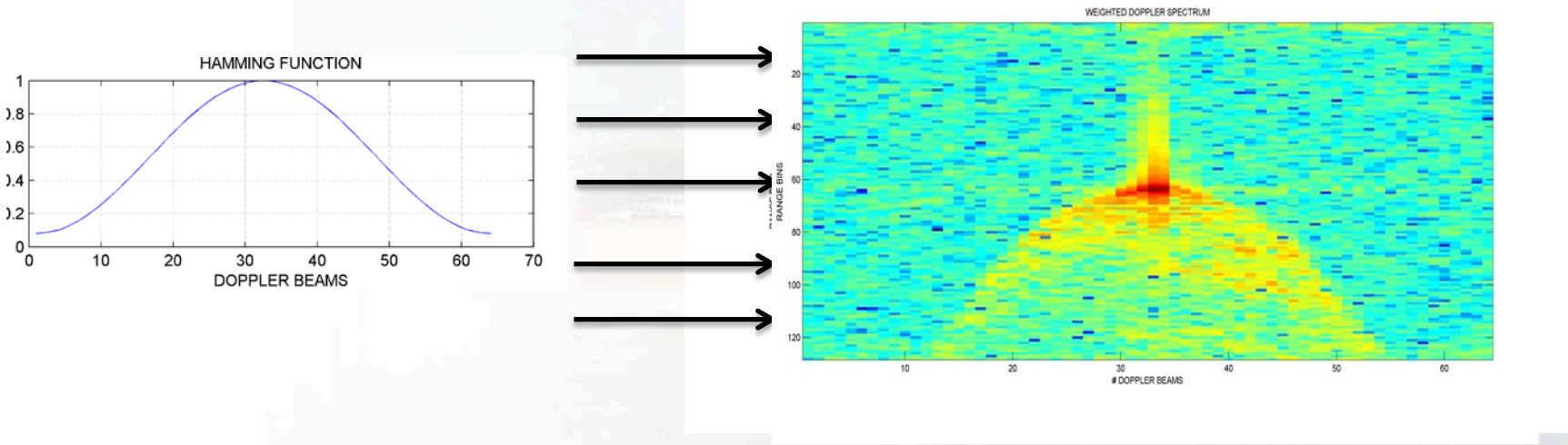
L1B Option – Hamming Window

Option Name	Option Value	Option Description
Hamming weighting Window	- Apply only in coastal zone - Yes, apply it - No. do not apply it	User can decide here whether to apply a Hamming weighting window on the SAR burst data, do not apply it, or to apply it only for surface location in coastal area (more info at REF1)

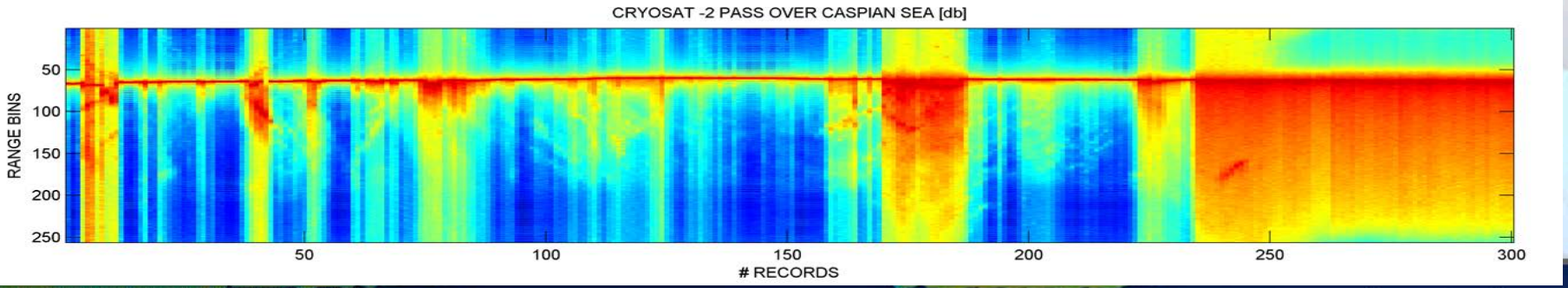
Default option: Apply only in coastal zone
Coastal Zone recommended: Apply only in coastal zone
Open Ocean recommended: No. do not apply it

Weighting Function in coastal zone

To suppress parabolic artifacts on the radargram to the quasi- specular coastal waters, => application of Weighting Function (Hamming) in Doppler Domain to Delay-Doppler Spectrum before the Beam Forming



Effect of the application of Weighting Function to eliminate parabolic artifacts on radargram (echo stack)



L1B Option – Exact Beam-Forming

Exact Beam-Forming	- Approximated - Exact	User can decide here whether to operate an exact Beam-Forming or an approximated Beam-Forming (more info at REF1)

* In the **approximate beam** steering, all the Doppler Beams will be steered by the same angle.
This approximation can be considered acceptable on **gentle undulating surfaces**.

* For effect of the application of the Beam Formation, the Doppler Beams are angularly Equispaced.
The **exact beam forming** needs to be applied in case of **highly variable topographic surfaces (land)**.

REF1, section 4.4

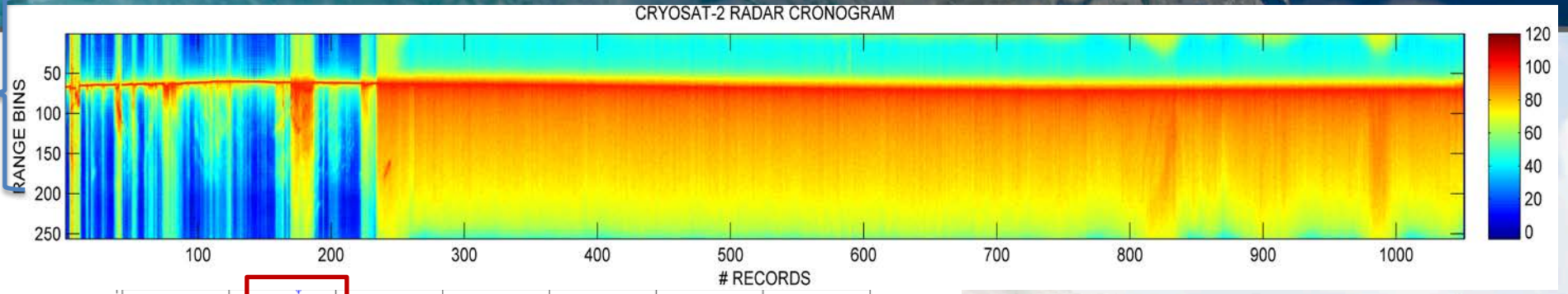
Default option: Approximated
Coastal Zone recommended: Approximated
Open Ocean recommended: Approximated

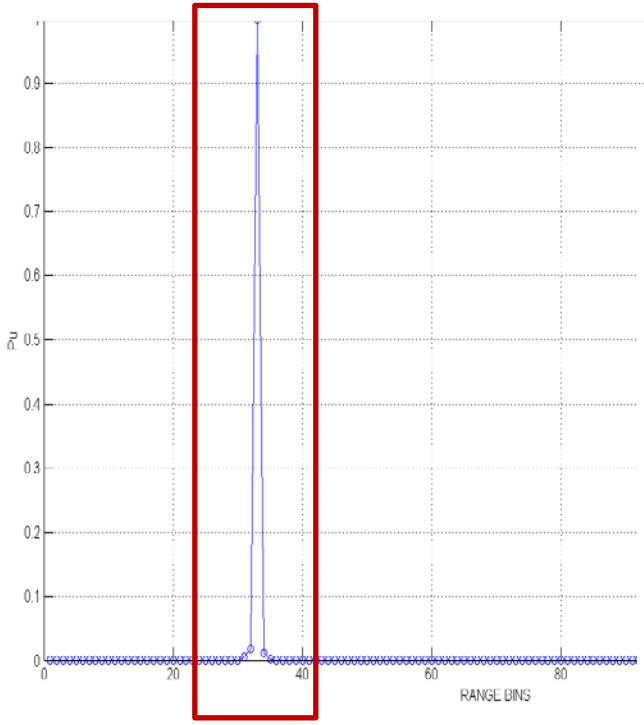
FFT Zero-Padding

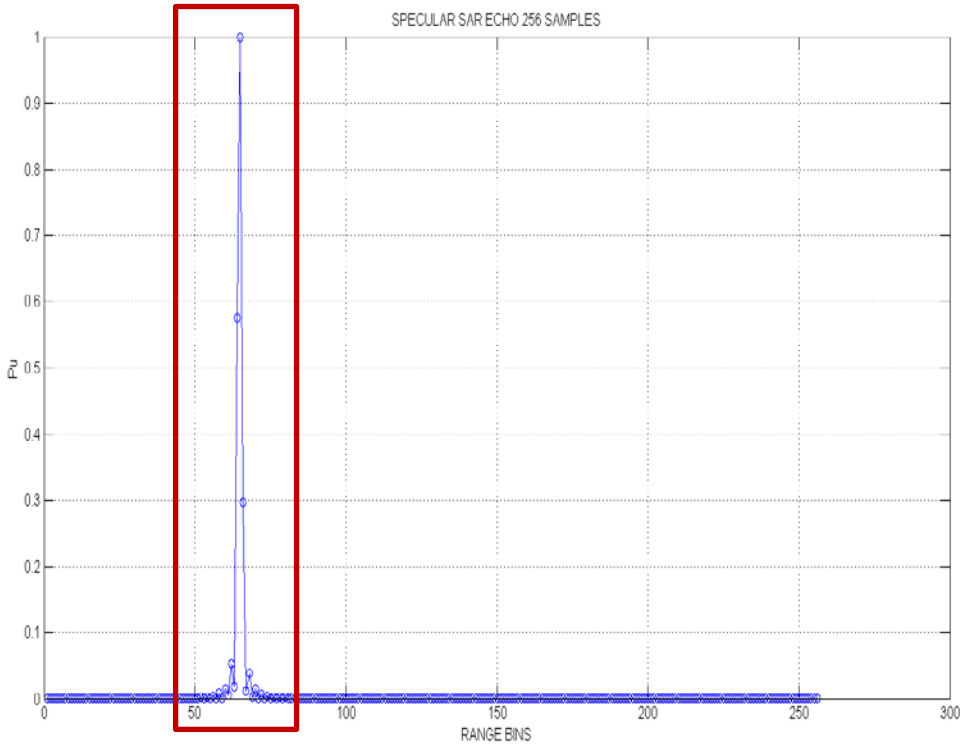
FFT Zero-Padding	- Yes, apply Zero-Padding - No, don't apply Zero-Padding	User can decide here whether to operate the Zero-Padding prior to the range FFT (**section 4.8 in REF1**). Zero-Padding is indicated for coastal zone and sea-ice analysis

Default option: Yes, apply Zero-Padding
Coastal Zone recommended: Yes, apply Zero-Padding
Open Ocean recommended: User pref

ZERO-PADDING =>DOUBLE SAMPLING



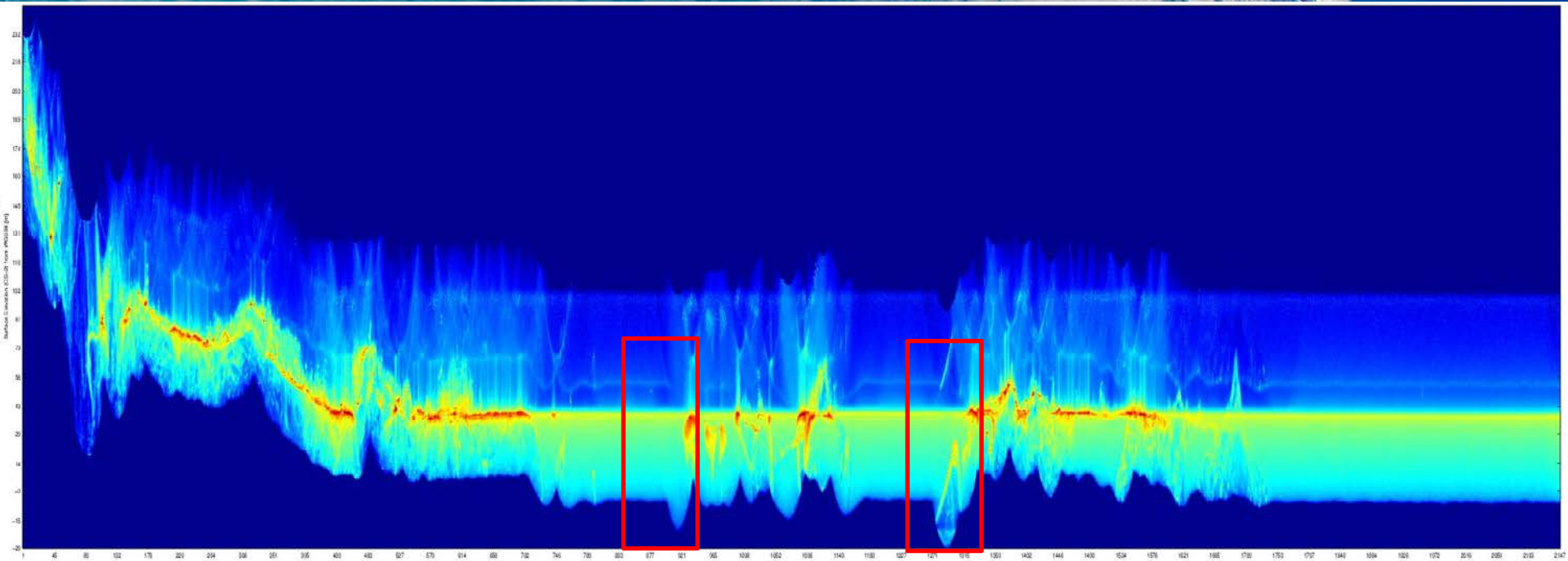


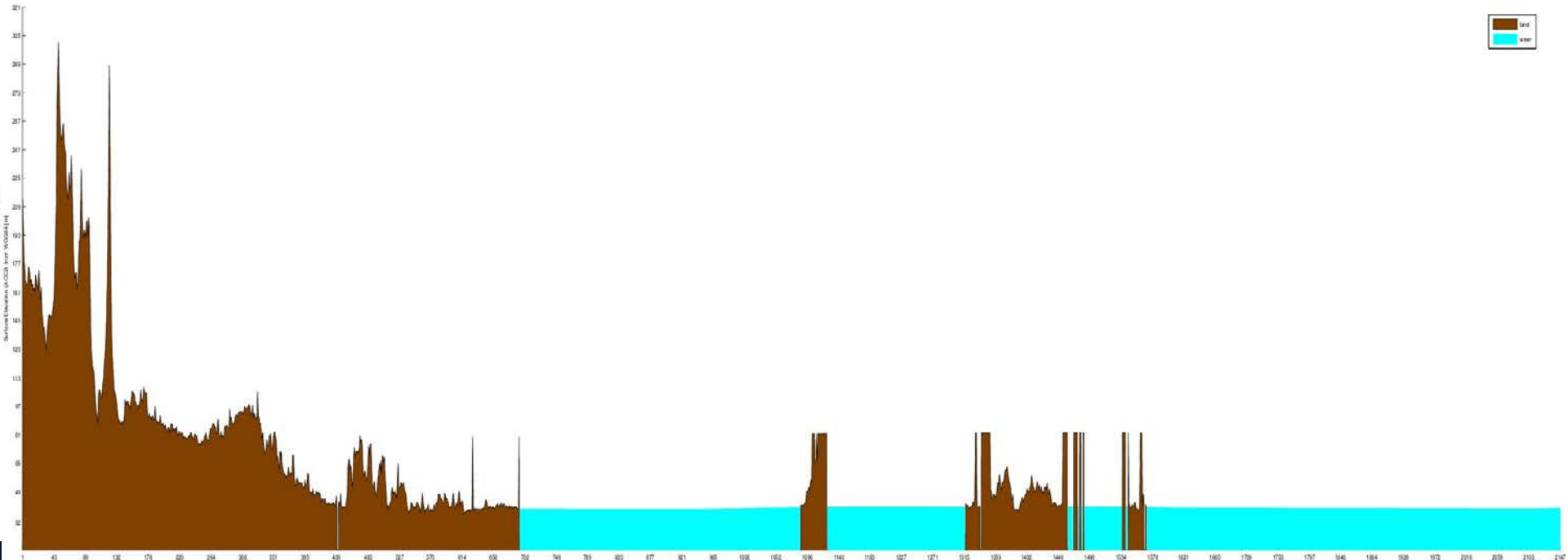


L1B Options – Window Size

Radar Receiving Window Size	- 128 Range Bins - 256 Range Bins	User can select here the size of the radar receiving window: 128 range bins (standard) or 256 range bins (extended). Extended window is indicated for coastal zone analysis

Default option: 128 Range Bins
Coastal Zone recommended:256 Range Bins
Open Ocean recommended: 128 Range Bins




land
water

L2 Options – Retracking Surfaces

Option Name	Option Value	Option Description
Restrict the re-tracking on specific surfaces	- Process all - Process only open sea points - Process only water points	User can decide here whether to process the whole pass, only points in open sea or only water points (points in open sea, costal zone and inland water)

Default option: Process only water points
Coastal Zone recommended: Process only water points
Open Ocean recommended: Process only open sea points

L2 Options – Slope Effect

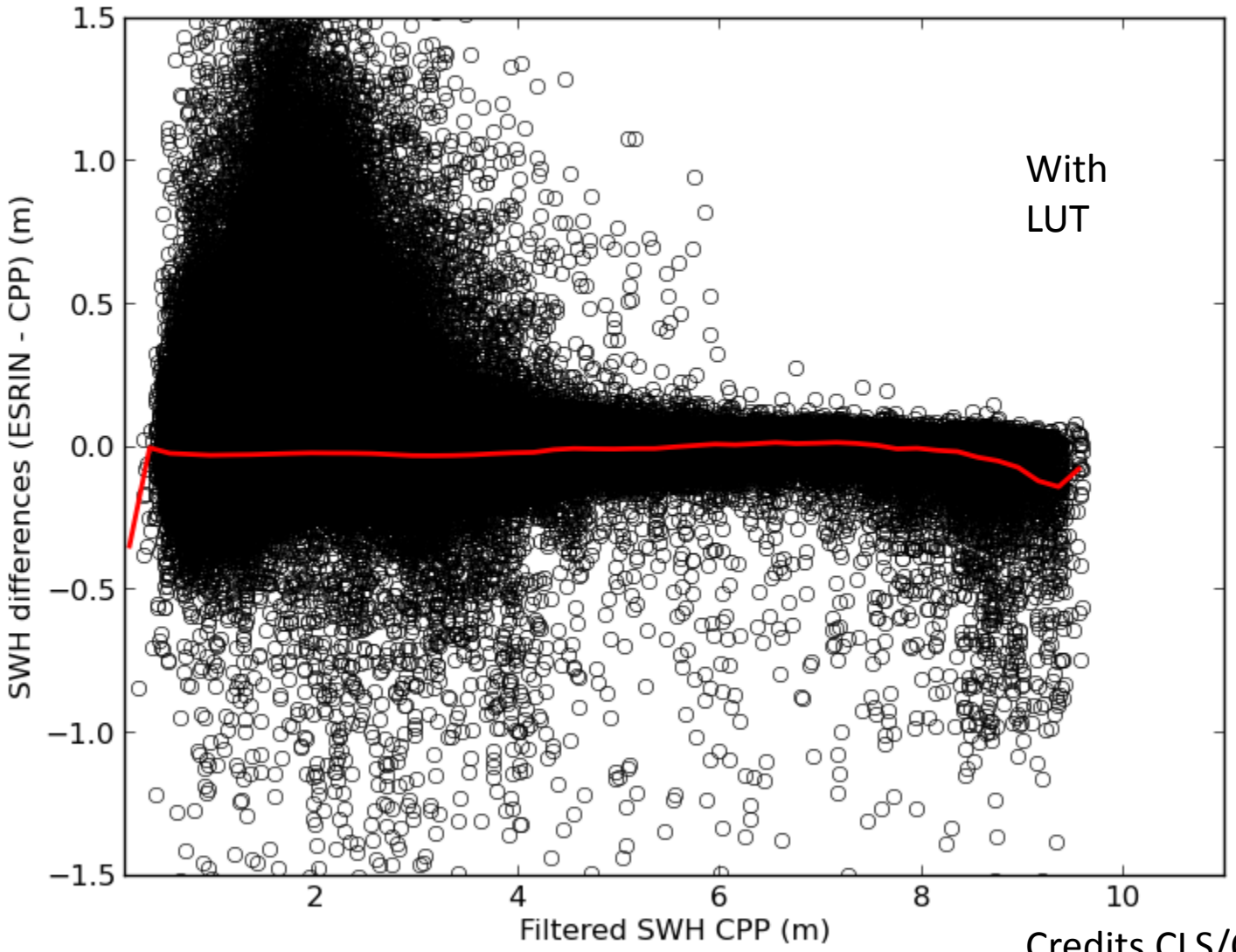
Slope Effect	- Yes, apply it - No. do not apply it	User can decide here whether to apply the slope effect in the SAMOSA model (more info at REF2)

Default option: - No. do not apply it
Coastal Zone recommended:? - No. do not apply it
Open Ocean recommended:? - No. do not apply it

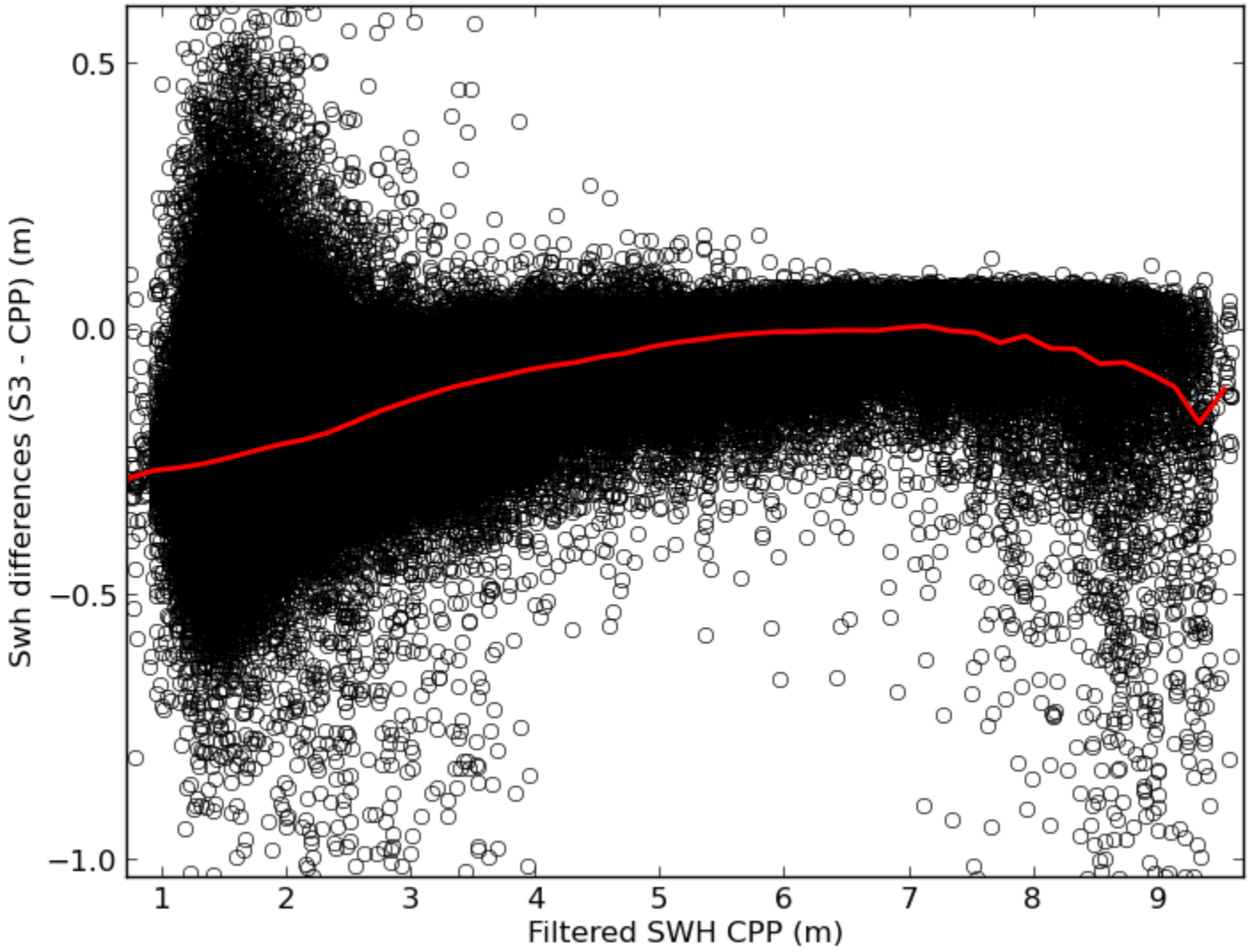
L2 Options – PTR width

PTR width alphap parameter	- LUT - Constant	User can decide here whether to use a LUT (Look-Up Table) or a constant for PTR (Point Target Response) alphap parameter

Default option: LUT
Coastal Zone recommended: LUT
Open Ocean recommended: LUT



Credits CLS/CNES



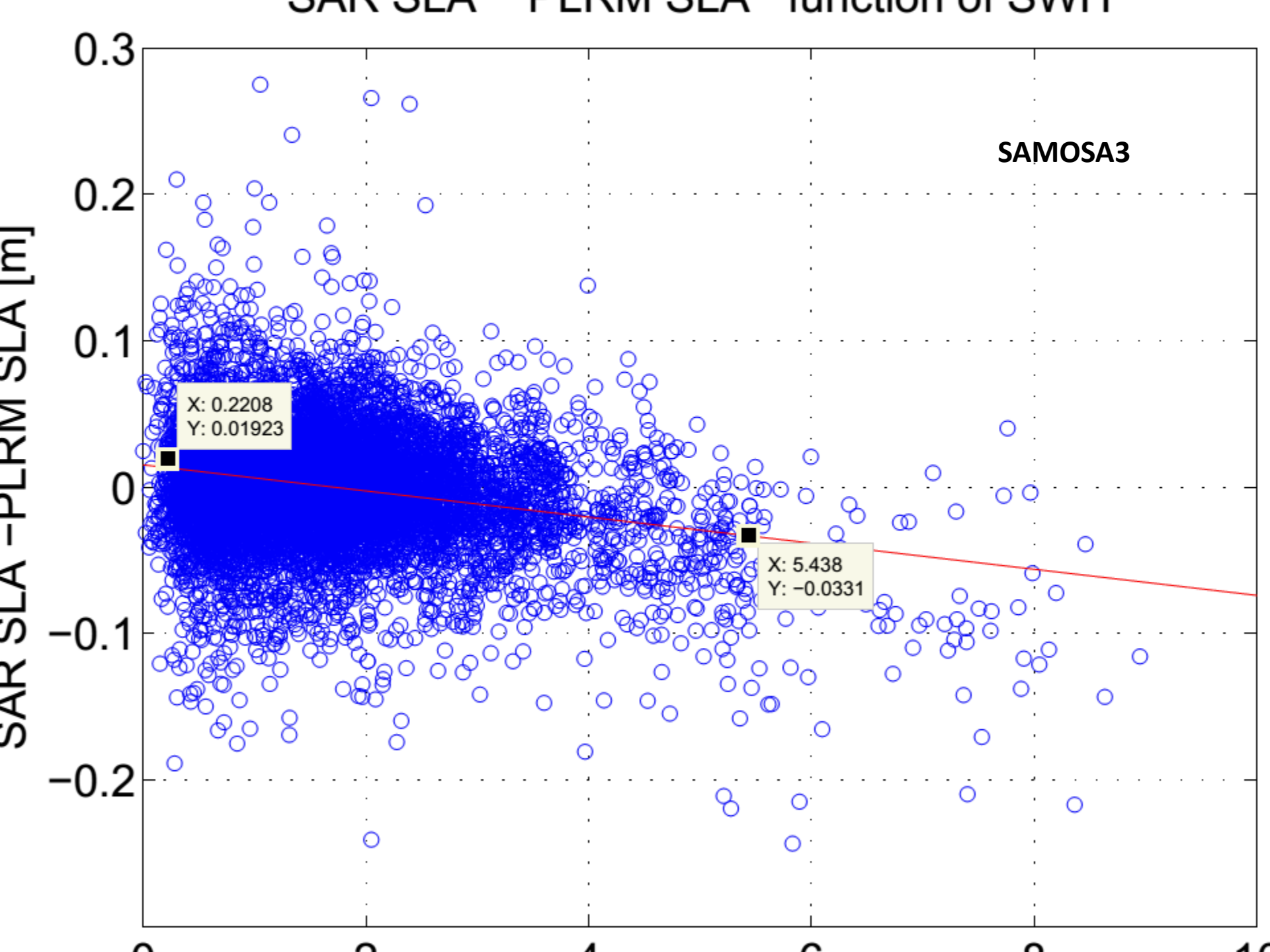
"SWH residual depends strongly on wave height (up to 25cm at very low swh) that could be due to the Gaussian approximation for the PTR "

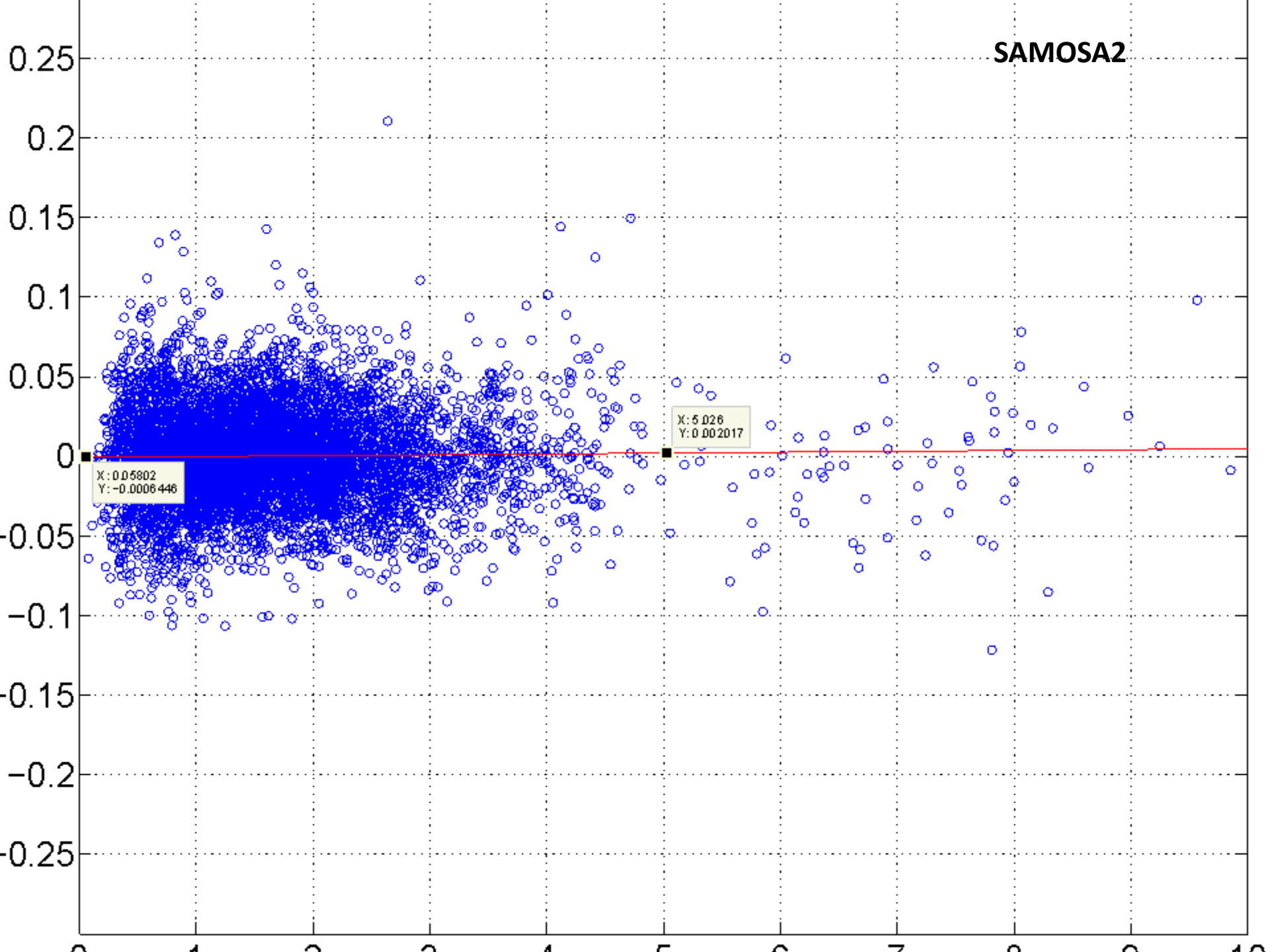
CNES/CLS

L2 Options – SAMOSA version

SAMOSA Model Generation	- Use SAMOSA 2 - Use SAMOSA 3	User can decide here which SAMOSA generation model to use in the processing (SAMOSA 2 or SAMOSA 3). The SAMOSA 3 is a truncated version of SAMOSA 2 (only zero-order term)

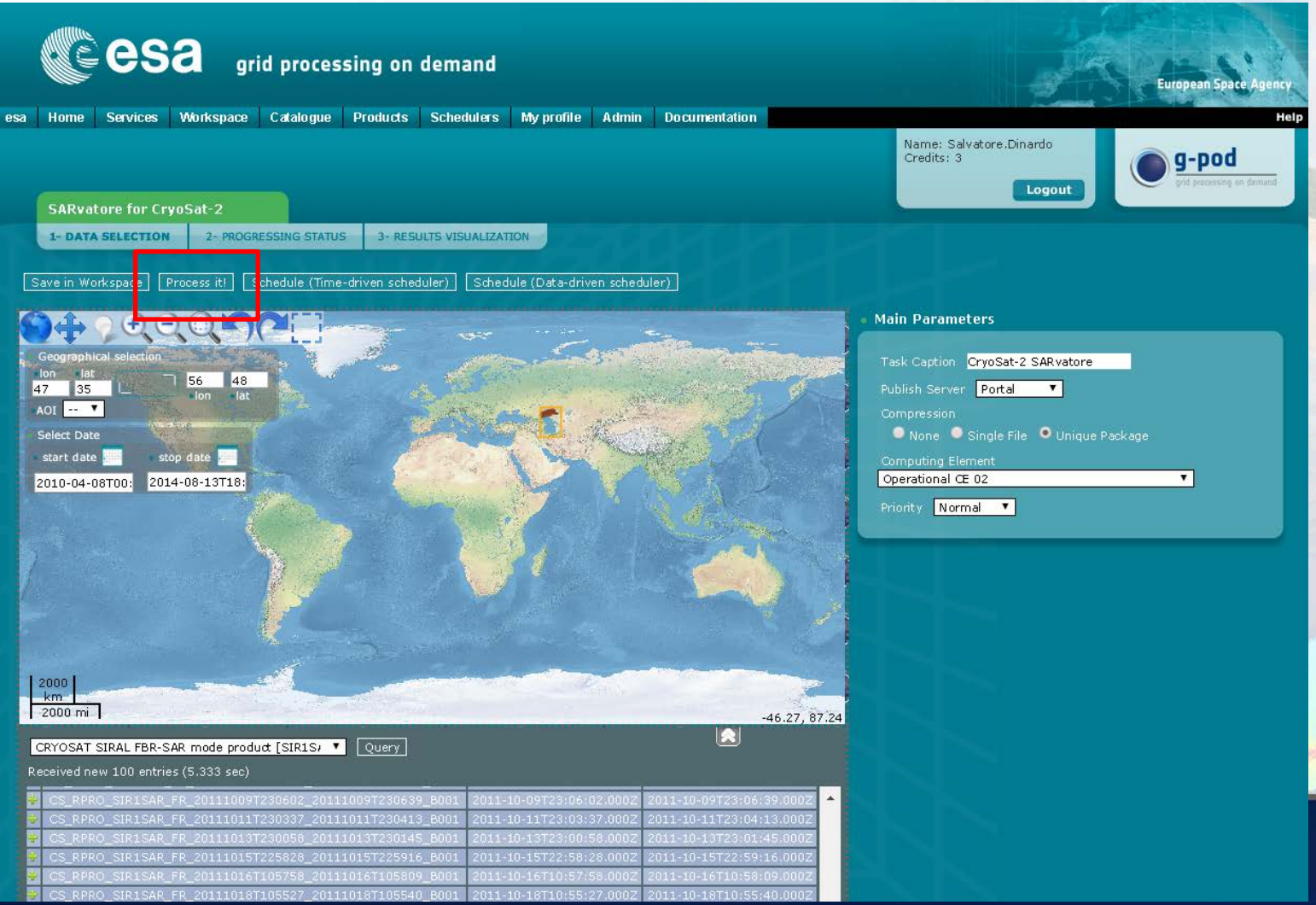
Default option: - Use SAMOSA 2
Coastal Zone recommended: - Use SAMOSA 2
Open Ocean recommended: - Use SAMOSA 2


SAR SLA −PLRM SLA [m]
0.3
0.2
0.1
0
−0.1
−0.2
SAMOSA3
X: 0.2208
Y: 0.01923
X: 5.438
Y: −0.0331


SAMOSA2
0.25
0.2
0.15
0.1
0.05
0
-0.05
−0.1
-0.15
−0.2
-0.25
X : 0.05802
Y : −0.0006446
X : 5.026
Y : 0.002017

TASK SUBMISSION

Once user has operated the selection of the processing options, in order to submit the task to G-POD Computing Elements, the user has to click on the “PROCESS IT” button.



TASK VIEWER/WORKSPACE

After submission of job, users will be directed to the workspace page where they can check in real time the status of the run and can be notified on the run status. The color code is:

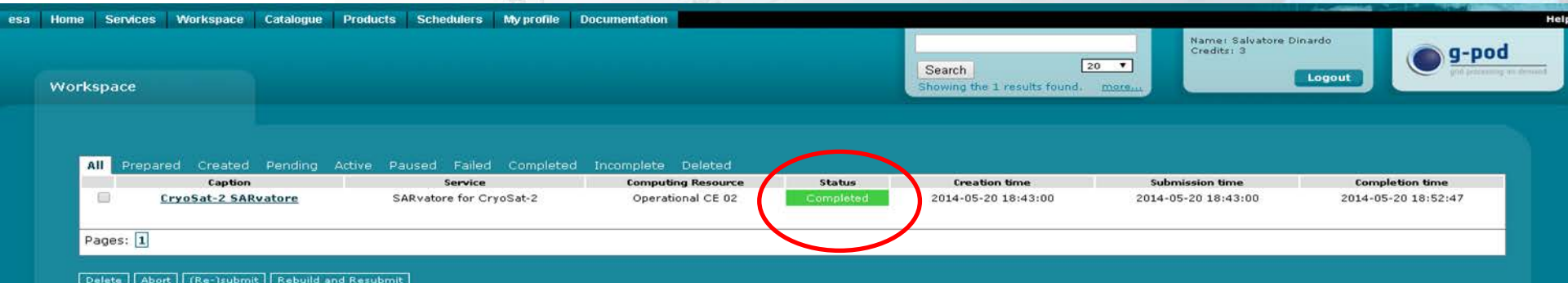
Orange → run under processing

Green → run completed

Red → run failed

Further, clicking on the task, the user can have more info on the processing task as:

- Task Id
- Processing Id
- Grid Working Node Id
- Task Progress (data retrieving, data processing, data publishing)
- Task Creation Time



TASK VIEWER/WORKSPACE

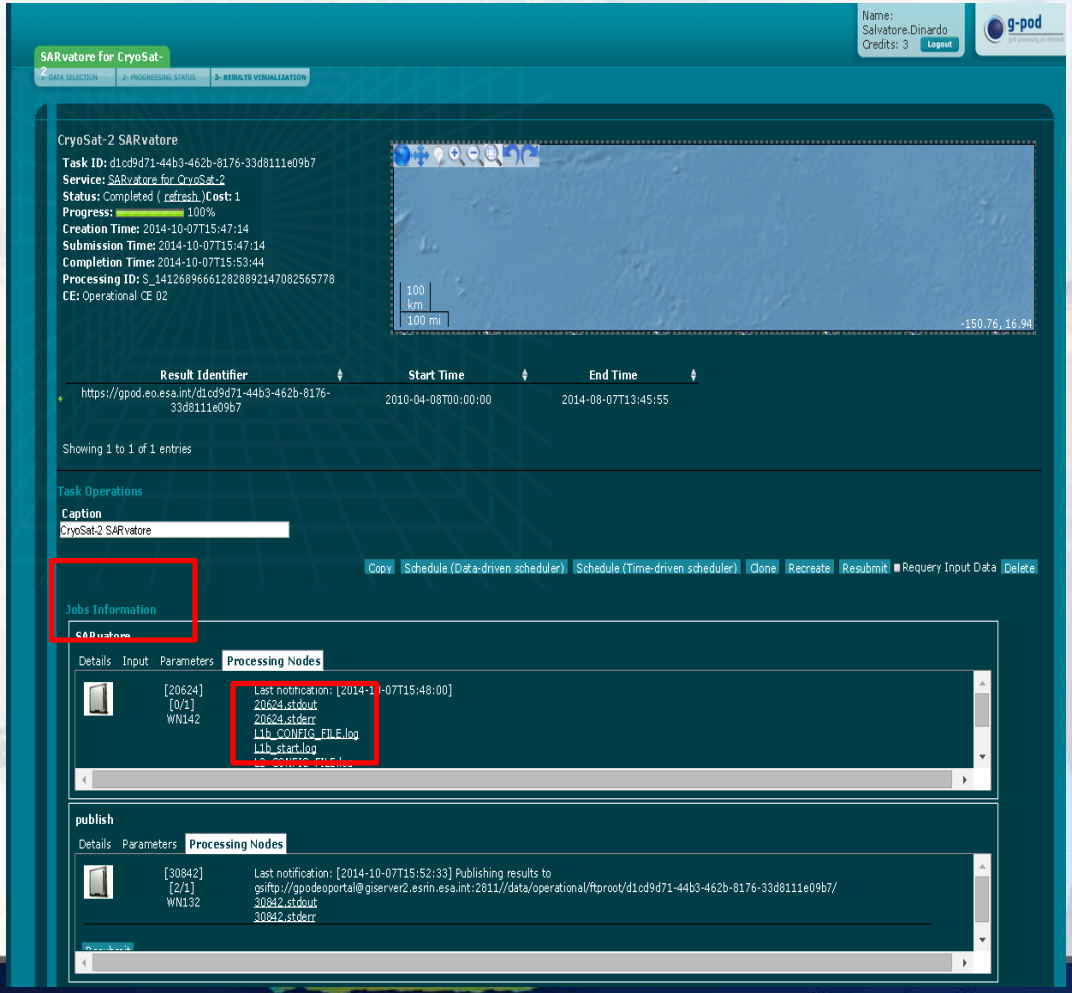
After run completion, clicking on the button “Jobs Information”, the user can inspect:

— the GPOD log file (.stdout or .stderr) where eventual errors on data retrieving or data storing are reported

— the prototype configuration file (L1b_CONFIG_FILE.log and L1b_CONFIG_FILE.log) where are reported all the processing options

— the prototype log files (L1b_start.log and L2_start.log) where are reported eventual prototype processing errors.

User can also decide to change one or more processing options and then re-submit the task.



Config and Log File (L1b) Example

```
##################### SARvatore L1b PROCESSOR PROTOTYPE CONFIGURATION FILE ##############################

#####################          SYSTEM PATHS                ###############################

DATA_FOLDER=/gpfs/gpfs01/RDIR/S_14126896861282889214708256577 8/SARvatore/20624/L1b_WDIR/

AUX_FOLDER=/gpfs/gpfs01/RDIR/AUX_DATA/

#########################################################################################################

#####################          CONFIGURATION FLAGS          ###############################

Weight_Flag=D
Beam_Forming_EXACT=N
Mean_Profile=N
Save_Stack=N
Gridding_Flag=LR
Extended_Window=Y
Zero_Padding_Flag=Y
#########################################################################################################

#####################       GEOGRAPHICAL SUBSETTING         ###############################

NORTH_LAT=-3
SOUTH_LAT=-13
EAST_LON=-32
WEST_LON=-38

#########################################################################################################
```

Configuration File Examples (L1B)

```
#########################################################################################################

SARvatore Processor Prototype
SAR Versatile Altimetry Toolkit for OLIW (Ocean-Land-Inland Water) Research and Exploitation

Current Run: CryoSat-2 SAR Mode L1b Processor
Current Version: 1.52

#########################################################################################################

Found 3 Passes to Process

---------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

Pass with 537 Records to Process

BLOCK START: 1 --> 200
Scenario Recovery: 1 --> 200
Gain and Calibration Correction: 1 --> 200
Beam Pointing: 1 --> 200
Beam Forming (Approximated): 1 --> 200
Beam Stacking: 1 --> 200
Scenario Recovery: 1 --> 200
Alignment and Range Compression: 1 --> 200
Elapsed time is 35.847286 seconds.
BLOCK END: 1 --> 200

BLOCK START: 201 --> 400
Scenario Recovery: 201 --> 400
Gain and Calibration Correction: 201 --> 400
Beam Pointing: 201 --> 400
Beam Forming (Approximated): 201 --> 400
Beam Stacking: 201 --> 400
Scenario Recovery: 201 --> 400
Alignment and Range Compression: 201 --> 400
Elapsed time is 27.736071 seconds.
BLOCK END: 201 --> 400

BLOCK START: 401 --> 537
Scenario Recovery: 401 --> 537
Gain and Calibration Correction: 401 --> 537
Beam Pointing: 401 --> 537
Beam Forming (Approximated): 401 --> 537
Beam Stacking: 401 --> 537
Scenario Recovery: 401 --> 537
Alignment and Range Compression: 401 --> 537
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Extrapolation going on with more than 4 samples
Elapsed time is 14.332029 seconds.
BLOCK END: 401 --> 537

Generating Output in kml, png and mat format

Output Generated -> Moving to Next Pass ...

Completed L1b Processing for the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.DBL

---------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR

No CryoSat-2 L1b File for: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.HDR -> File Skipped


---------------------------------------------

Processing the Pass: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.TGZ
```

Execution Log

Config and Log File (L2) Example

```
################### SARvatore L2 PROCESSOR PROTOTYPE CONFIGURATION FILE ###############################

###################          SYSTEM PATHS          ###############################

DATA_FOLDER=/gpfs/gpfs01/RDIR/S_14126898661282889214708256578/SARvatore/20624/L1b_RES_DIR/

AUX_FOLDER=/gpfs/gpfs01/RDIR/AUX_DATA/

#########################################################################################################

###################          CONFIGURATION FLAGS          ########

SAVE_NETcdf_Flag=Y
ZONE_TYPE_Flag=WATER
SLOPE_Flag=OFF
DDM_Mask_Flag=ON
AlphaPTR_LUT=alphaPTR_table_05_Aug_2014.txt
Model_Flag=SAM2
Dump_Echo_Flag=N
#########################################################################################################
```

You don't need to care about it

(if everything goes ok)

```
#########################################################################################################

SARvatore Processor Prototype
SAR Versatile Altimetry Toolkit for OLIW (Ocean-Land-Inland Water) Research and Exploitation

Current Run: CryoSat-2 SAR Mode L2 Processor
Current Version: 1.49

#########################################################################################################

Found 3 Passes

---------------------------------------

I am processing the file: CS_OFFL_SIR1SAR_FR_20140619T042952_20140619T043016_B001.kml

File Not Recognized --> Pass Skipped

                                                    20140619T042952_20140619T043016_B001.mat

Fitted Normalized Pu: 4.5481
RMSS: 0.55874
TN: 0.0044883
MISFIT: 1.71 %
******************************
******************************
No of Waveform: 80 / 537
Elapsed time is 0.181051 seconds.
Fitted Epoch in ns: 226.2723
Fitted SWH in m: 1.4183
Fitted Normalized Pu: 3.759
RMSS: 0.63868
TN: 0.037863
MISFIT: 3.04 %
******************************
******************************
```

Execution Log

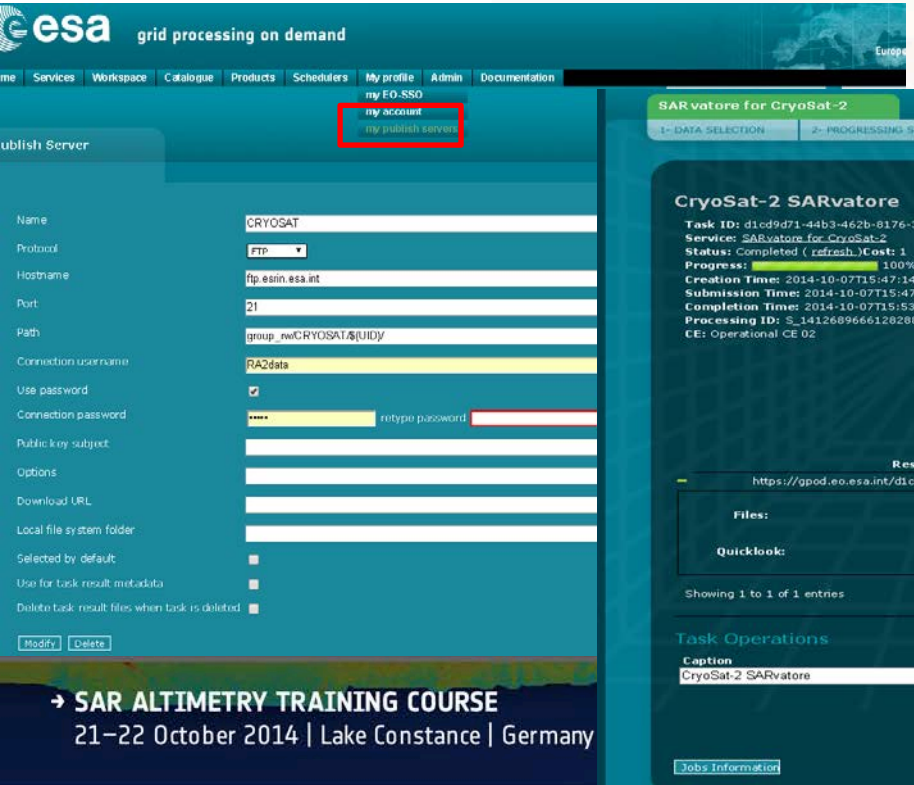
Configuration File Examples (L2)

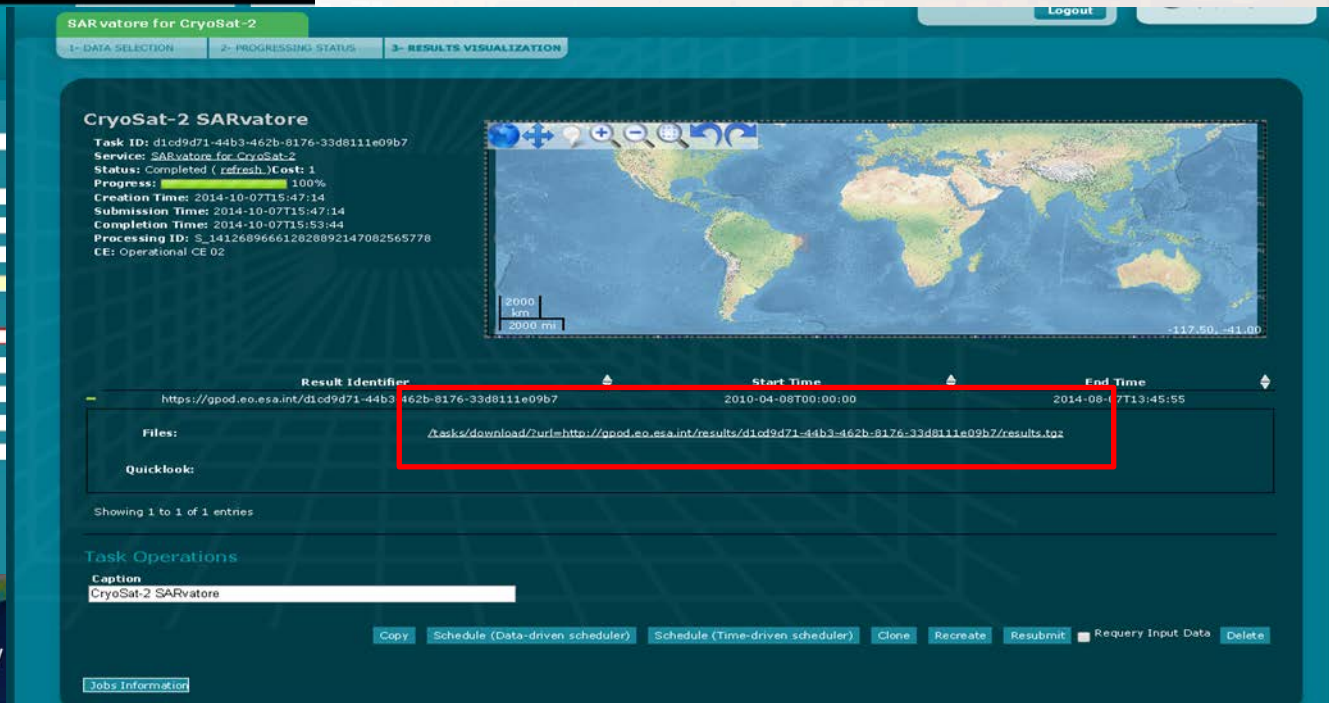
Output Package Publishing

In case of successful run completion (green status), the portal will provide user a http link from where to download the output package on own local drive.

The user can order to post the package directly on own personal ftp server once that he communicated to the web platform his ftp server credentials (through my “publish servers” sub-menu).

This is the recommended option in case of processing of large amount of data.





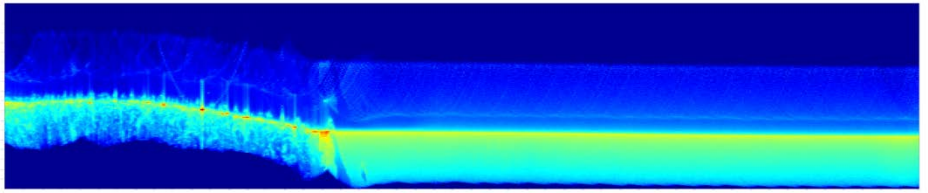
Output Package Content

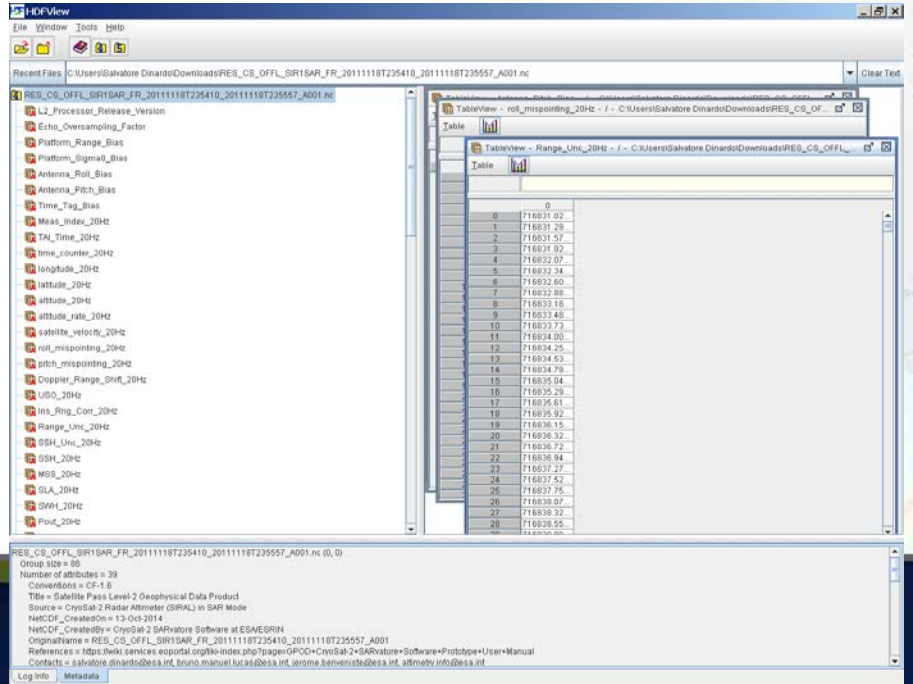
The output package consists of :

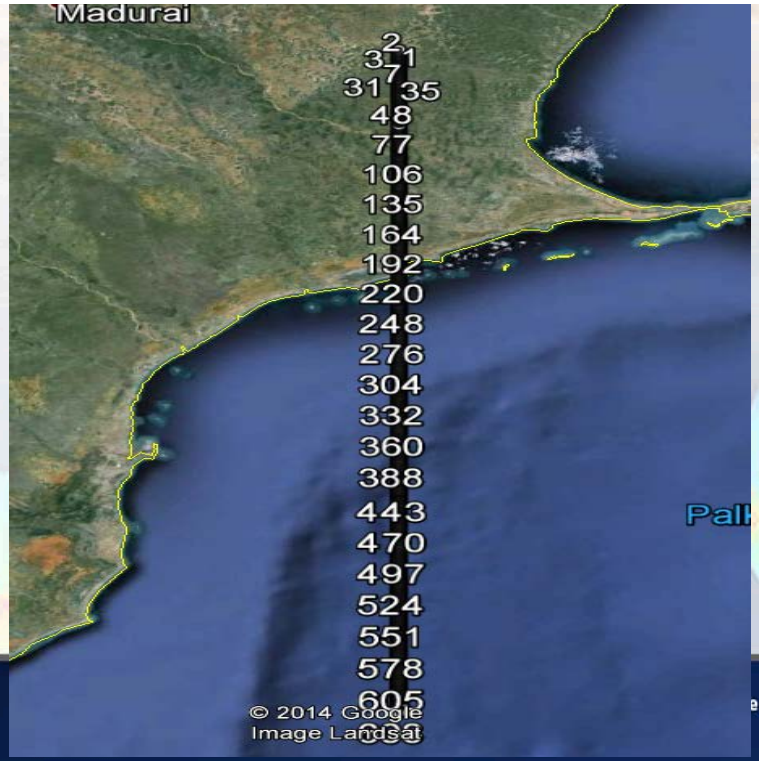
— Pass Ground-Track in KML format

— Radar Echogram Picture in PNG format

— L2 data product in NETcdf format with all the scientific results. The netCDF format is self-explanatory with all the data field significance described in the attributes







Adopted Conventions

- The Reference Time for the TAI Datation is 01/01/2000 00:00:00
- The Vertical Datum for altitude reference is the WGS84 Ellipsoid
- The Curve Best-Fitting Scheme, used in the re-tracking stage, is a bounded Levenberg-Marquardt Least-Squares Estimation Algorithm (LEVMAR-LSE).
- The mispointing angles are treated as input into retracking algorithm
- The SAR Power Return Waveform Model, used in the re-tracking stage, is the SAMOSA Model (REF2)
- Static bias has been applied to the range, sigma nought and antenna mispointing measurements. The values of the static biases are reported in the output NetCDF data products.
- The orbital altitude has been corrected for a Time Tag Bias. The value of the applied time tag bias is reported in the output NetCDF data products.
- The measurements are posted both at rate of 20 Hz and of 1 Hz.
- The sea state bias has not been applied to the sea level anomaly measurements.
- No *a priori* data editing has been applied to the 20 Hz measurements.
- The misfit between SAR Waveform Model and SAR Waveform Data has been computed as:

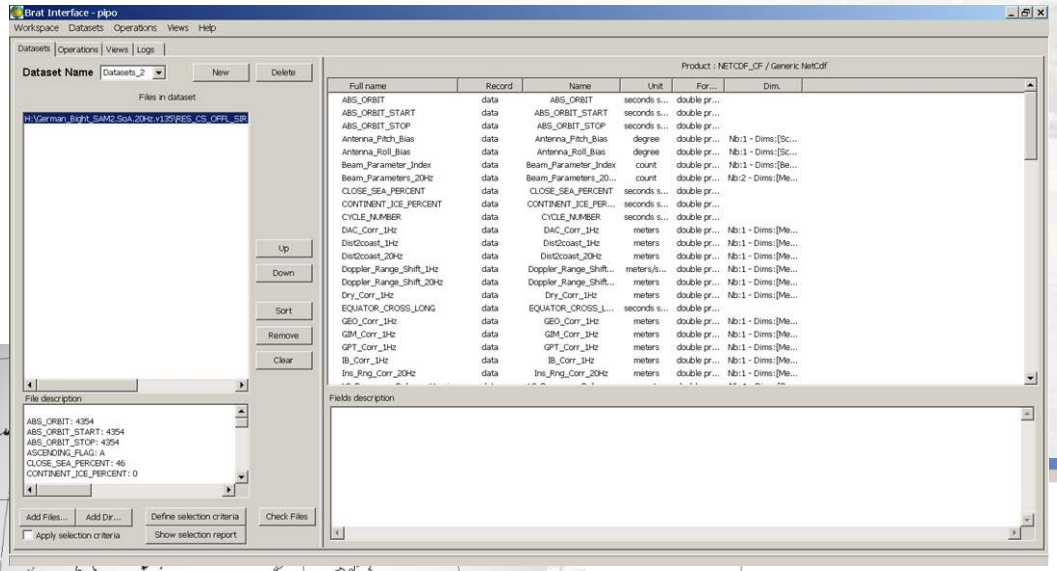
  sqrt(1/128*(residuals).^2)*100

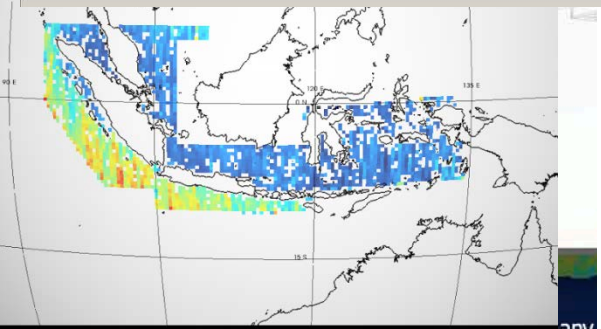
  where residuals are the differences between model's waveform power and data's waveform power, normalized for the waveform power's maximum value.

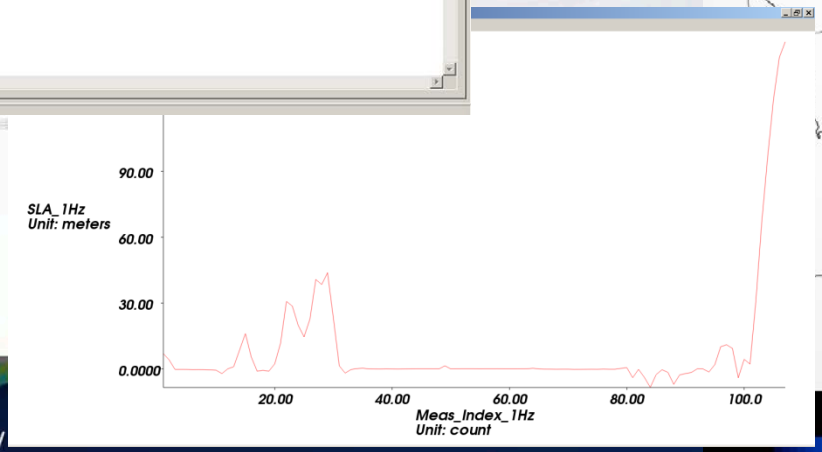
NETcdf Product IN BRAT

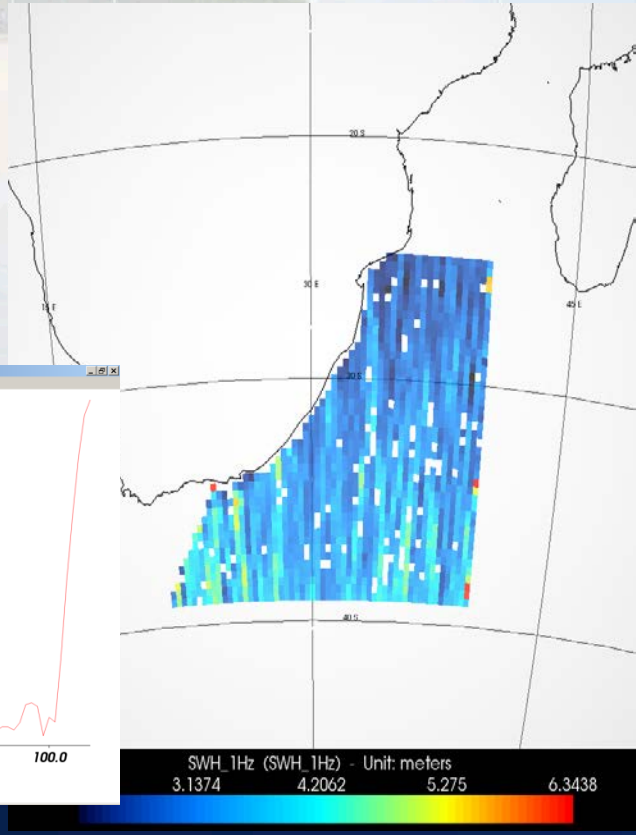
The NETcdf product follows the CF (Climate&Forecast) 1.6 Convention and can be opened with any standard NETcdf tools (ncdump, HDFview, etc)

Anyhow, the recommended option is to ingest the NETcdf product in BRAT Toolbox in order to exploit all the BRAT functionalities to browse and visualize the output content









CONTACTS & REFERENCES:

- For any question, bugs and support, please contact us at:
  altimetry.info@esa.int
- For G-POD platform specific questions please contact:
  eo-gpod@esa.int
- Service Manual available at: http://wiki.services.eoportal.org/tiki-index.php?page=GPOD+CryoSat-2+SARvatore+Software+Prototype+User+Manual
- Service available at:
  https://gpod.eo.esa.int/services/CRYOSAT_SAR/

— REF1: Guidelines for the SAR (Delay-Doppler) L1b Processing, ESA, 2013
— REF2: SAR Altimeter Backscattered Waveform Model (SAMOSA Model Paper), IEEE-TGARSS, in press

THANK YOU !

Further inquiries @:

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